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City of San Diego
Public Utilities Department

March 2022

LIST OF VOLUMES

APPENDIX O

RE-ENTRAINMENT

City of San Diego
Public Utilities Department

March 2022

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Acronyms and Abbreviations

ATSD	EPA Amended 301(h) Technical Support Document
City	City of San Diego
cm/sec	centimeters per second
cm^2/sec	square centimeters per second
CTD	conductivity, temperature, and depth
EPA	United States Environmental Protection Agency
m	meters
m^2	square meters
m/sec	meters per second
m^2/sec	square meters per second
m^3/sec	cubic meters per second
mgd	million gallons per day
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan, Ocean Waters of California
PLOO	Point Loma Ocean Outfall
rms	root-mean-square
SWRCB	State Water Resources Control Board

O.1 BACKGROUND

This appendix evaluates re-entrainment associated with the discharge plume of the Point Loma Ocean Outfall (PLOO). Re-entrainment computations presented in this appendix were originally presented in the City of San Diego's (City's) 1995 301(h) waiver application and were performed in accordance with re-entrainment computational procedures set forth in the United States Environmental Protection Agency (EPA) 301(h) Amended Technical Support Document. Dilution, flow, ocean currents, and receiving water conditions remain the same as those addressed in the original 1995 re-entrainment analyses, so the approach and information presented in the 1995 301(h) application (presented again herein) remain valid and applicable to the current PLOO discharge. As documented within Appendix D (Plume Behavior and Tracking Summary) and Appendix P (Oceanography), the PLOO discharge remains trapped below the ocean surface during virtually all conditions. Ongoing ocean current measurements by permanently moored ocean current monitors near the PLOO discharge point continue to show that longshore currents predominate, and that net annual currents below the thermocline are typically northwestward at speeds of several centimeters per second (cm/sec). Further, ongoing plume tracking studies conducted using acoustic Doppler measurements, remotely-operated towed vehicles, and autonomous underwater vehicles continue to (1) show minimal potential for re-entrainment of the PLOO discharge, and (2) show consistency with the 1995 re-entrainment computations presented herein.

Re-entrainment is the mixing of previously discharged effluent or contaminants back into the discharge plume. The effect of re-entrainment is to lessen the effective dilution of discharged wastewater into ambient receiving waters. The PLOO diffuser, discharge depth, and location were designed on the basis of modeling and oceanographic studies to minimize the potential for such re-entrainment.

This appendix evaluates re-entrainment associated with the PLOO discharge. To assess re-entrainment effects, computer simulations of wastefield characteristics were performed using conservative assumptions and observed data for ocean currents, ocean density profiles, wastefield thickness, and discharge characteristics. The simulations demonstrate that re-entrainment effects associated with the PLOO discharge are minor. Smallest re-entrainment effects on initial dilution (approximately 4%) were simulated under February conditions. Largest effects on initial dilution (up to 12.1%) occurred during summer conditions. Because initial dilutions tend to be high during such summer conditions, however, re-entrainment does not have a significant effect on overall outfall performance during any simulated conditions.

O.2 INTRODUCTION

Wastewater is carried out of the discharge area, and replaced with new effluent free water, by ocean currents. The spatial dimensions of the wastefield, the strength of the ocean current, and the discharge rate are related to the dilution through the relationship:

$$S_a \cdot Q = H_w \cdot W_w \cdot V_a \qquad Equation\ O-1$$

where: S_a = flux-averaged initial dilution

Q = volumetric discharge rate of effluent (cubic meters per second (m^3/sec))

H_w = depth of the water column occupied by wastewater (meters (m))

W_w = "effective" width of the wastefield (m)

V_a = speed of the ocean current (meters per second (m/sec))

At high current speeds, this relationship is satisfied by a decrease in the thickness and width of the wastefield, and by an increase in the initial dilution (e.g., proportional to $V_a^{1/2}$ for flow perpendicular to the diffuser - Roberts et al. 1989).

At lower current speeds, for inviscid (frictionless) flow in density stratified water, the initial dilution becomes independent of current speed and the wastefield width increases (e.g., due to the discharge-induced currents) to maintain the relationship. Over longer time- and length-scales, the effective width of the wastefield, and hence the dilution, can increase due to fluctuations in the component of the ocean flow perpendicular to the dominant direction of flow (e.g., tidal and more slowly varying changes) and by lateral diffusion.

The actual dilution achieved by the outfall, however, may be less than expected if previously discharged wastewater is re-entrained into the plume during the initial dilution process. This re-entrainment may occur under a number of circumstances. Over short time-scales and in the immediate vicinity of the outfall, the effects of viscosity can promote vertical mixing, re-entrainment, and the development of distortions in the local pressure and flow fields that result in "blocking."

Longer periods of very weak currents can result in additional perturbations of the density structure of the ocean due to the entrainment of angular momentum. Even if the currents are relatively strong, re-entrainment may occur if reversals in the flow coincide with downward movements of previously formed segments of the wastefield (e.g., due to downwelling and internal tides).

If all the conditions required for re-entrainment occur, the concentration of effluent in the wastefield will be increased, resulting in a reduction in the "effective" dilution.

The magnitude of the effective initial dilution is related to the volumetric flux-averaged initial dilution and the concentration of ambient effluent in the entrained water by the equation:

$$C_w = \frac{(S_a - 1) \cdot C_a + C_e}{S_a} \qquad Equation\ O-2$$

where: C_w = concentration of effluent in the wastefield

C_a = concentration of effluent in the entrained receiving water

C_e = concentration of effluent (set at a value of 1.00, e.g., 100%)

S_a = volumetric flux-averaged initial dilution

Under these circumstances, the "effective" initial dilution (i.e., the dilution achieved based on the concentration of effluent in the wastefield at the completion of the initial dilution process) is:

$$C_w = \frac{S_a \cdot C_a + C_3}{S_a + 1} > \frac{S_a \cdot 0 + C_e}{S_a + 1} = \frac{C_e}{S_a + 1} = C_w^o \qquad Equation\ O-3$$

where: C_w = effluent concentration in the wastefield with re-entrainment

C_w^o = effluent concentration in the wastefield without re-entrainment

C_a = effluent concentration in the entrained ambient water

C_e = effluent concentration in the wastewater (established at a value of 1.00, e.g., 100%)

S_a = flux-averaged initial dilution

The *Water Quality Control Plan, Ocean Waters of California* (hereinafter Ocean Plan) establishes receiving water standards to be achieved upon the completion of initial dilution, and requires that minimum month initial dilutions be used for establishing National Pollutant Discharge Elimination System (NPDES) effluent concentration limits required to implement the receiving water standards.[1] As discussed in Appendix Q (Initial Dilution Simulation Models), initial dilutions over a month (30-day period) may be computed as a flux average, as follows:

$$S_{avg} = \frac{\int_0^{30\,dy} S_a(t')dt'}{30\ days} \qquad Equation\ O-4$$

where: S_{avg} = 30-day average initial dilution

S_a = instantaneous flux-averaged initial-dilution at time, t'

If re-entrainment may occur (e.g., due to current reversals), calculation of the individual effective dilutions making up the monthly-averaged value requires simultaneous information on the volumetric flux-averaged initial dilution and the concentration of previously discharged effluent in the ambient water entrained into the plume.

As discussed in Appendix Q, numerous methods have been developed for computing the volumetric flux-average initial dilutions (e.g., Baumgartner et al, 1993). Nonetheless, it is difficult to provide detailed three-dimensional spatial and temporal descriptions of previously discharged wastewater in the receiving water environment that are required to describe the re-entrainment of effluent into the initial dilution plume. This is especially true in density-stratified coastal waters characterized by short coherence length-scales for cross-shore currents and internal wave activity, such as exist in the environment off Point Loma. For example, none of the simulation models suggested in the *Amended 301(h) Technical Support Document* (ATSD) are appropriate for this environment.

1 The most recent version of the Ocean Plan was adopted by the State Water Resources Control Board (SWRCB) in 2019.

O.3 METHODOLOGY

O.3.1 General Approach

In lieu of such a model, a simplified approach was adopted in order to obtain an estimate of the possible effects of effluent re-entrainment on the discharge from the PLOO. Since the Ocean Plan specifies a minimum month (30-day average) initial dilution for purposes of translating Ocean Plan Table O-3 receiving water standards (to be achieved upon completion of initial dilution) into effluent concentration standards, an appropriate approach is to calculate the volume of effluent discharged during a 30-day period, and the volume of ocean water containing this effluent. Since 100% of the PLOO discharge is wastewater (e.g., the concentration of wastewater in the effluent is 100%, or 1.00), the average concentration of effluent in this volume of ocean water is:

$$C_w^{avg} = \frac{V_e^{dschg}}{V_a^{eff}} \qquad Equation\ O-5$$

where: V_a^{eff} = volume of ambient water containing 30 days of discharged effluent

V_e^{dschg} = volume of effluent discharged during the 30 days is given by $V_e^{dschg} = Q \cdot T$

Q = volumetric discharge rate of effluent (m³/sec)

T = elapsed time (30 days ≈ 2.6 x 10^6 sec)

C_w^{avg} = average concentration of effluent in the volume V_a^{eff}

Under the conservative assumption that the receiving water in the entrainment region of the water column near the outfall diffuser always contains previously discharged effluent at this concentration, the effective initial dilution associated with the volumetric initial dilution S_e becomes:

$$S_e = \frac{(1 - S_a^*) \cdot S_a^*}{C_w^{avg} \cdot S_a^* + 1} \qquad Equation\ O-6$$

where: S_a^* = the Ocean Plan-defined initial dilution, computed as $S_a^* = S_a - 1$, where S_a is the EPA-defined initial dilution

If the average concentration of effluent in the entrained receiving water, C_w^{avg}, is much less than the initial concentration of effluent in the wastefield in the absence of any re-entrainment, C_w^o, then:

$$S_e \cong \left[\left(1 - C_w^{avg}\right) \cdot S_a^*\right] \cdot \left[1 - C_w^{avg} \cdot S_a^*\right] \approx \left(1 - C_w^{avg}\right) \cdot S_a \qquad Equation\ O-7$$

Under these conditions, the 30-day average effective initial dilution is approximately equal to the average of the individual dilutions occurring during the 30-day period, weighted by the factor (1 - C_w^{avg}).

O.3.2 Volumetric Estimations

The primary task then is to estimate the volume of ambient water that contains effluent discharged during the previous 30 days. This volume reflects the effects of the ocean currents, oceanic mixing, temporal fluctuations in the depth of isopycnal surfaces in the water column, and variations in the initial position of the wastefield in the water column.

The calculation begins by estimating the longshore extent of this volume (the principal direction of transport). The approach follows the method described in Hendricks, 1992. The first step is to separate the longshore component of the ocean currents into two parts: (1) a net current and (2) fluctuations about the net flow.

$$V_x(t) = V_x^o + V_x^*(t) \qquad \textit{Equation O} - 8$$

where: $V_x(t)$ = longshore component of the ocean current at time, t

V_x^o = longshore component of the net current

$V_x^*(t)$ = longshore component of the current fluctuations about the mean value at time, t

If there are no fluctuating currents ($V_x^*(t)=0$), then the longshore length of the volume containing the previous 30 days of discharge is simply $L_x = V_x^o\,\tau$, where τ = 30 days. On the opposite extreme, suppose that the net current is zero, $V_x^o = 0$, but the variable part of the current carries water 50 km upcoast during the 15 days, then reverses and moves 15 km back downcoast. Now the longshore length of the volume containing 30 days of discharge is 50 km. In general, the longshore currents will consist of a net flow plus fluctuations of various time-scales superimposed on the net flow. A statistical approach is used to estimate the longshore transport associated with this mixture of flows.

Suppose first that the currents in the longshore direction have no net flow ($V_x^o = 0$). If the wastefield is represented by a series of contiguous segments, the distribution of the centers-of-mass of these segments will depend on the characteristics of the variations in the longshore currents. These fluctuations can be represented by a series of cosine functions:

$$V_x^*(t) = \sum_{i=1}^{N/2} V_{x_i} \cdot \cos(\omega_i \cdot t + \varphi_i) \qquad \textit{Equation O} - 9$$

where: V_{x_i} = longshore component of current fluctuations associated with the angular frequency ω_i

ω_i = angular frequency associated with the period, $T_i = 2\pi f_i = 2\pi/T_i$

φ_i = phase associated with the fluctuation at period T_i

N = number of current measurements during the time τ

T_i = $i \cdot \Delta t$, *where* $\Delta t = \tau / N$

Assuming that the measured currents are representative of the currents everywhere within the area of interest (progressive vector hypothesis), the position of a wastefield segment at a time t (= $n{\cdot}\Delta t$), after it was formed is:

$$x(t) = \int_0^t V_x^*\,(t')dt' \cong \sum_{i=n}^{N/2} \frac{-vx_i}{\omega_i} \cdot \sin(\omega_i \cdot t \cdot \varphi_i) + \int_0^{n\Delta T} \sum_{i=1}^{n-1} vx_i \cdot \cos(\omega_i \cdot t' \cdot \varphi_i)dt' \qquad Equation\ O-10$$

The first summation term of Equation O-10 represents the movement associated with fluctuations characterized by periodicities equal to or shorter than the elapsed time, *t*. The second summation term of Equation O-10 represents the motions associated with fluctuations with periodicities longer than this time. During the elapsed time, *t*, these motions appear to be associated with fluctuations about the net velocity, but without the cyclical characteristics of the motions associated with the initial summation term of the equation.

Each wastefield segment has a different beginning time associated with it. These differences in starting time can be accommodated by a change in the phase angles, φ_I (this is analogous to constructing an ensemble of motions by randomizing the phase angle - Hendricks, 1978; Koh, 1988). If each component in the cosine series can be considered as independent (Hendricks, 1975), then a measure of the distribution of the positions of the centers-of-mass of the wastefield segments is the variance of this series:

$$VAR_x^* = \sum_{i=n}^{N/2} \left(\frac{vx_i}{\omega_i}\right)^2 + (n \cdot \Delta t)^2 \cdot \sum_{i=i}^{n-1} (vx_i)^2 \qquad Equation\ O-11$$

The variance of a uniform distribution of half-width, W_2, is:

$$VAR = \frac{1}{2}\,(W_2)^2 \qquad Equation\ O-12$$

where: σ_x = standard deviation

W_2 = $\sqrt{2} \cdot \sigma_x$

The width of this distribution is related to the temporal properties of the currents by the relationship:

$$(W_2)^2 = 2 \cdot \left\{ \sum_{i=n}^{N/2} \left[\frac{vx_i}{\omega_i}\right]^2 + (n \cdot \Delta t)^2 \cdot \sum_{i=1}^{n-1} (vx_i)^2 \right\} \qquad Equation\ O-13$$

In the occurrence of a net flow V_x^o, a systematic shift will occur in the center of mass of each wastefield segment by an amount equal to $V_x^o \cdot i\ \Delta t$. Thus, the total (statistical) length of the region occupied by effluent discharged during the 30-day period is:

$$L_x = \sqrt{2} \cdot \sqrt{0.5 \cdot (V_x^o \cdot \tau)^2 + VAR_x^*} \qquad Equation\ O-14$$

The same approach can be applied to the cross-shore flows. However, since all the net flow was attributed to the longshore component, the width of the distribution in the cross-shore direction is limited to the standard deviation of the fluctuations in this direction:

$$L_y = 2 \cdot \sqrt{2 \cdot VAR_x^*} \qquad Equation\ O-15$$

It is noted, however, that there will be lateral (oceanic) mixing even in the absence of measured fluctuations in the cross-shore component of the currents. The variance associated with this mixing (assuming a diffusion velocity representation) is:

$$VAR_{diff-vel} = \sigma^2_{diffuser} + (v_{diff} \cdot t)^2 \qquad \text{Equation } O-16$$

where: $\sigma_{diffuser}$ = variance associated with initial wastefield width at the conclusion of initial dilution

v_{diff} = diffusion velocity (cm/sec)

t = elapsed time (seconds)

As documented in Appendix S (Analysis of Ammonia), this representation provides a good description of the subsequent dilution of ammonia in the wastefield generated by PLOO for a diffusion velocity of 1 cm/sec. Similar values have been reported in measurements at a variety of other oceanographic sites (Okubo and Pritchard, 1969; Okubo, 1970).

If the lateral mixing is a process independent of the fluctuating currents in the cross-shore direction, the width of the distribution for the 30 days of discharged effluent would be:

$$L_y = 2 \cdot \sqrt{2 \cdot (VAR_{diff-vel} + VAR_y^*} \qquad \text{Equation } O-17$$

However, the measured fluctuations in the cross-shore component of the ocean currents may be responsible for some of the lateral mixing. Therefore, the (conservative) assumption was adopted so that the lateral (cross-shore) width of the distribution was equal to the larger of the variances associated with lateral diffusion *or* the cross-shore current fluctuations:

$$L_y = 2 \cdot \sqrt{2 \cdot MAX(VAR_{diff-vel}, VAR_y^*)} \qquad \text{Equation } O-18$$

The area of the ellipse containing the discharged effluent is:

$$AREA = \pi \cdot \left(\frac{L_x}{2}\right)\left(\frac{L_y}{2}\right) \qquad \text{Equation } O-19$$

O.3.3 Wastefield Thickness

The thickness of the wastefield is estimated in a similar manner. Factors contributing to the effective thickness include:

- the mean thickness of the wastefield,
- variation about the mean thickness,
- variation in the level of minimum dilution in the water column,
- vertical movements of isopycnal surfaces due to internal tides, internal waves, and upwelling and downwelling, and
- vertical mixing.

Thus, the thickness of the uniform concentration layer containing the 30 days of discharged effluent is:

$$H_{eff} = 2\sqrt{2} \cdot \sqrt{(H_w/2)^2 + \sigma_w^2 + \sigma_h^2 + \sigma_I^2 + 2 \cdot \sigma_v^2} \qquad Equation\ O-20$$

where: H_w = mean thickness of the wastefield (m)

σ_W = standard deviation in the thickness of the wastefield (m)

σ_h = standard deviation in the height-of-rise to the level of minimum dilution (m)

σ_I = standard deviation of the vertical motion of the isopycnal surfaces (m)

σ_V = standard deviation of the vertical spreading associated with vertical mixing (m)

The standard deviation associated with vertical mixing is related to the vertical diffusivity by the equation:

$$\sigma_v^2 = 2 \cdot k_z \cdot \tau \qquad Equation\ O-21$$

where: k_z = vertical diffusivity (square meters per second (m^2/sec))

O.4 INPUT DATA

O.4.1 Ocean Currents

Current meter data from Mooring C5 during 1990 and 1991 were used in this re-entrainment analysis. These measurements were made in the vicinity of the new outfall diffusers, but prior to its construction. The mean height-of-rise to the level of minimum dilution for a discharge of 205 million gallons per day (mgd) is about 26.6 m, thus the mean depth to the level of minimum dilution is about 67 m. Currents were measured at depths of 20, 40, 60, and 80 m at C5. Therefore, the average effluent concentration was computed in the ambient water using the records collected depths of 60 and 80 m. A linear interpolation was used to estimate the ambient effluent concentration at a depth of 67 m.

Each cosine series representing a time-series of current measurements was constructed using a power-of-2 fast Fourier transform. Because of this, none of the periods in the series precisely matched a period of 30 days. Therefore, the variances associated with the fluctuations in the longshore and cross-shore currents were computed for each time-series for durations that were shorter and longer than 30 days. Variances for durations of 30 days or more were estimated by interpolation.

The measurements at the 60- and 80-m depths were subdivided into seasons since the properties of the currents can change with season as well as depth. The months of January, February, and March were grouped together, since this period was the period of lowest predicted initial dilutions (see Appendix Q, Initial Dilution Simulation Models). The January-March group is labeled as winter, and the months of April, May, and June were designated as spring. Similarly, the months of July, August, and September were designated as summer, and

October, November, and December were designated as the fall season. The measurements at the 60- and 80-m depths at Mooring C5 for the spring and fall periods contained data gaps that were too long to be reliably estimated from the prior and following sections of the time-series. Therefore, the measurements collected at a depth of 60 m at Mooring C4 (lying inshore in 87 m of water) were used for these two periods. The measurements at a depth of 77 m at Mooring C4 were too close to the bottom to be used as a reliable estimator of the currents at typical wastefield depths above the bottom. Thus, only the concentration of effluent at a depth of 60 m could be estimated for these two periods.

Although the net current was not always aligned with the longshore axis, it was assumed that the net flow was in this direction. Since it will be shown that the length of the ellipse (longshore axis) containing the discharged effluent is greater than its width (cross-shore), this assumption has the conservative effect of underestimating the area of the ellipse, and hence overestimating the ambient effluent concentration. The net flows and variances associated with each current meter and season are summarized in Table O-1 (page O-10).

O.4.2 Lateral Diffusion

In Appendix R (Dissolved Oxygen Demand), it was demonstrated that lateral mixing could be described with a diffusion velocity representation using a diffusion velocity of 0.01 m/sec (1 cm/sec). A diffusion velocity of 0.005 m/sec was used for the re-entrainment simulations. The motivation for this reduced velocity was that the inshore spreading of the wastefield resulting from oceanic mixing may be limited by the presence of the coastal boundary.

O.4.3 Effective Wastefield Thickness

The mean height-of-rise of the wastefield was about 26.6 m for a discharge of 205 mgd (see Appendix Q, Initial Dilution Simulation Models). The Ocean Plan requires that the initial dilutions be calculated without any enhancement from the currents (i.e., by setting the speed of the currents at zero in the simulations). For weak currents, the mean initial thickness of the wastefield is about 10% greater than the height-of-rise to minimum dilution (Roberts et al., 1989), or about 29.4 m.

The height-of-rise of the wastefield to the level of minimum dilution varies roughly uniformly between about 20.2 m (10^{th} percentile) and 33.4 m (90^{th} percentile), hence the standard deviation, σ_H, is about 3.3 m. The corresponding standard deviation for variations in the thickness of the wastefield is 3.7 m.

Table O-1:
Current Velocity Input Data

Mooring	Depth (m)	Year	Season	Current Speed (cm/sec)			Days
				V_{net}	Standard Deviation V_x	Standard Deviation V_y	
5	60	1990	Winter	4.9	28.0	10.7	42.7
5	60	1990	Winter	4.9	17.4	8.2	21.3
5	80	1990	Winter	6.5	32.0	11.0	42.7
5	80	1990	Winter	6.5	17.7	6.3	21.3
5	60	1991	Winter	2.1	34.9	14.4	42.7
5	60	1991	Winter	2.1	27.6	10.6	21.3
5	80	1991	Winter	1.3	31.0	9.1	42.7
5	80	1991	Winter	1.3	18.7	3.1	21.3
4	60	1990	Spring	3.5	42.8	12.6	42.7
4	60	1990	Spring	3.5	20.0	5.2	21.3
5	60	1990	Summer	2.0	29.4	11.4	42.7
5	60	1990	Summer	2.0	20.9	6.3	21.3
5	80	1990	Summer	0.8	31.3	9.6	42.7
5	80	1990	Summer	0.8	20.4	7.1	21.3
4	60	1990	Summer	2.1	25.4	6.6	42.7
4	60	1990	Summer	2.1	17.2	4.5	21.3
4	60	1990	Fall	3.3	23.0	4.22	21.33
4	60	1990	Fall	3.3	5.1	1.99	7.11

A vertical diffusivity of 0.125 x 10^{-4} m^2/sec (0.125 square centimeters per second (cm^2/sec)) was assumed. This is one-eighth the value suggested in Appendix B of the *301(h) Amended Technical Support Document*. The diffusivity was reduced to reflect the presence of the ocean bottom below the wastefield, and increased density stratification above the wastefield. The standard deviation associated with vertical diffusion over a 30-day period, σ_V, is about 11.4 m.

Isopycnal surfaces (as indicated by isotherms) undergo vertical motions as the result of internal tides and internal waves. These oscillations introduce wastewater into different density layers of the water column at semi-diurnal and diurnal frequencies. The horizontal length-scales corresponding to tidal excursions are on the order of a kilometer, or less. Therefore, the horizontal length-scales characterizing the packets of wastewater within the various density layers are on the order of 0.5 km, or less. Horizontal oceanic mixing rapidly spreads these relatively small-scale packets to fill in the gaps.

The strings of thermistors at Moorings T2 through T5 measured internal tide associated root-mean-square (rms) vertical excursions of isotherms (contours of constant water temperature) of 4.2 m during 1990, and 6.6 m during 1991. These magnitudes were used for the standard deviations of the vertical motions of the isopycnal surfaces, σ_I. This is a conservative assumption since it ignores the effects of the vertical motions of comparable, or larger, magnitude that occurred over time-scales of days to weeks (e.g., associated with upwelling and downwelling).

O.4.4 Discharge Flux

A flow of 205 mgd was used for the calculations. The 205 mgd flow was the maximum average flow projected to occur during the initial 301(h) 5-year NPDES period.[2] This 205 mgd flow corresponds to a flow of about 9 m^3/sec, or a volume of 1.3 x 10^8 m^3 over the 30-day period.

O.5 RESULTS

The average ambient water concentrations in the 30-day ellipse are summarized for each season and depth in Table O-2 (page O-12). As noted earlier, current meter data for the spring and fall seasons were only available for measurements made at a depth of 60 m at Mooring C4.

To compare estimates based on the measurements at the moorings, the ambient background effluent concentrations were computed for the summer season using the data from Moorings C4 and C5. This comparison showed that the ambient background concentration for the summer period, based on the current data recorded at Mooring C4, was comparable with the concentration estimated from data collected at the same depth at Mooring C5.

2 Use of this 205 mgd flow for assessing oxygen-demand effects remains valid to the present day. PLOO discharge flows remain well below the maximum average annual 205 mgd PLOO discharge flow estimated in the City's original 1995 301(h) application. Additionally, all subsequent PLOO 301(h) permits (including Order No. R9-2017-0007, NPDES CA0107409) have utilized the 205 mgd flowrate for purposes of establishing mass emission limits and for purposes of determining the need for antidegradation analysis.

Table O-2:
Ambient Effluent Concentrations

Mooring	Depth	Season	Year	Concentration of Effluent in the Wastefield[3]	
				205 mgd PLOO Discharge	240 mgd PLOO Discharge
5	60	Winter	1990	0.00022	0.00026
5	80	Winter	1990	0.00017	0.00020
5	60	Winter	1991	0.00032	0.00038
5	80	Winter	1991	0.00055	0.00064
4	60	Spring	1990	0.00029	0.00034
5	60	Summer	1990	0.00045	0.00053
5	80	Summer	1990	0.00038	0.00044
4	60	Summer	1990	0.00045	0.00053
4	60	Fall	1990	0.00031	0.00036

Table O-3 (page O-13) summaries the effect of re-entrainment on the volumetric initial dilutions. The median dilution values are based on the time-series data. The monthly initial dilutions are the Ocean Plan initial dilutions based on the conductivity, temperature, and depth (CTD) data. The effects of re-entrainment on the monthly initial dilution values were estimated in the following manner:

1. The average height-of-rise to the level of minimum dilution above the diffuse port was subtracted from a water depth of 96 m.
2. The background concentration at this depth was estimated by interpolation between the background concentrations at the 60- and 80-m depths for the appropriate season.
3. The Equation O-6 (page O-4) was used to compute the effective initial dilution for these conditions.

The background concentration for the median initial dilution was estimated in a similar manner using the 50th percentile height-of-rise to the level of minimum dilution, and the average of the seasonal background concentrations. Overall, the effect of re-entrainment was to reduce the volumetric initial dilutions by 8.4% to 8.7%. The largest reductions (12.1%) occurred for a flow of 25 mgd in the months of July and September. The smallest reduction (4%) was for a flow of 205 mgd in February, using the background concentrations based on the currents in 1990.

3 Ratio of discharged effluent to ambient water in the wastefield (e.g., pure wastewater equals a concentration of 1.00).

Table O-3:
Effective Initial Dilution after Re-Entrainment

Data Period	Computed Initial Dilution			
	205 mgd PLOO Discharge		240 mgd PLOO Discharge	
	Volumetric Initial Dilution	Effective Initial Dilution	Volumetric Initial Dilution	Effective Initial Dilution
Median[4]	*365:1*	*317:1*	*338:1*	*317:1*
January[5,6]	214:1	206:1	292:1	195:1
January[5,7]	214:1	195:1	292:1	185:1
February[5,6]	204:1	196:1	224:1	215:1
February[5,7]	204:1	186:1	224:1	203:1
March[5,6]	264:1	251:1	263:1	250:1
March[5,7]	264:1	238:1	263:1	237:1
April[5]	313:1	280:1	284:1	257:1
May[5]	315:1	281:1	295:1	265:1
June[5]	354:1	313:1	324:1	290:1
July[5]	325:1	286:1	320:1	282:1
August[5]	317:1	286:1	294:1	262:1
September[5]	317:1	279:1	307:1	271:1
October[5]	287:1	264:1	281:1	259:1
November[5]	264:1	244:1	249:1	231:1
December[5]	217:1	203:1	206:1	194:1

4 Time series data (13,757 cases) with observed ocean currents.

5 Based on CTD data with ocean current velocity set to zero.

6 Based on ocean current data from 1990.

7 Based on ocean current data from 1991.

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APPENDIX P

OCEANOGRAPHY

City of San Diego
Public Utilities Department

March 2022

APPENDIX P

Oceanography

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APPENDIX P

Oceanography

SECTION P-1 | OVERVIEW

In the nearshore coastal waters of the Southern California Bight (SCB), ocean conditions are influenced by multiple factors. These include:

(1) large-scale climatic processes, such as the El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO), which can affect long-term trends (Peterson et al. 2006, McClatchie et al. 2008, 2009, Bjorkstedt et al. 2010, 2011, 2012, Wells et al. 2013, NOAA/NWS 2020);

(2) the California Current System, coupled with local gyres that transport distinct water masses into and out of the SCB (Lynn and Simpson 1987, Leising et al. 2014); and

(3) local driving mechanisms such as internal waves, internal tides, upwelling (Huyer et al. 1979), local winds (Dong et al. 2009, Nam and Send 2011) and seasonal changes in local weather patterns (Bowden 1975, Skirrow 1975, Pickard and Emery 1990), which are a primary driver of water column stratification typically observed off San Diego and in coastal waters throughout the rest of southern California (Terrill et al. 2009, Rogowski et al. 2012a,b, 2013).

These seasonal patterns typically include warmer and more stratified waters in the dry season (May through September), and cooler, more weakly-stratified and well-mixed waters, in the wet season (October through April) (e.g., City of San Diego 2015a, Hess 2019, Hess 2020).

The review presented here supplements and updates oceanographic information for the SCB originally presented in the City's 1995 301(h) application and included in subsequent applications (e.g., Appendices P and Q, City of San Diego 2015a). This review includes a summary of the oceanographic conditions presented in prior submissions, including direct excerpts, and provides more recent information specific to the Point Loma coastal region.

SECTION P-2 | BATHYMETRY

The complex bathymetry within the SCB is defined by a series of coastal basins and troughs, submarine ridges and islands, a nearshore shelf and slope, and submarine canyons. The shelf itself extends from the coast to the 200-meter isobath at the upper edge of the continental slope approximately 200 kilometers (km) off Newport Beach, California. The combined area of the SCB continental shelf inshore of the continental slope is about 104,000 km^2 (Emery 1960, NRC 1990). The majority of this area, approximately 63 percent, is associated with basin and trough slopes, whereas the remaining area comprises a mix of basin and trough floors (17 percent), bank tops, islands, and island shelves (14 percent), and the mainland shelf (6 percent). In contrast, North of Point Conception, and south of the border with Mexico, the width of the continental shelf is generally about 20-35 km.

The mainland shelf off Point Loma is about 6.5 km wide. A narrow rocky shelf runs parallel to the coast, extending from the shoreline to water depths of 17 to 20 meters (m) (Moore 1957). The outer edge of a bed of *Macrocystis* and *Pelagophycus* kelps marks the offshore edge of this rocky shelf. At its outer edge, the bottom drops sharply by about 3 to 18 m, terminating in a relatively smooth, gently sloping plain (Moore 1957). This plain extends seaward to a depth of about 90 to 95 m, and with only minor variations in direction and width for at least 15 km to the north and south of the Point Loma Ocean Outfall (PLOO). About 23 km north of the PLOO, the shelf is intersected by Scripps Canyon, and 17 km to the south by the Coronado Canyon.

At the outer edge of the mainland shelf from Point Loma, the bottom slopes sharply downward, descending into the Loma Sea Valley (Moore 1957). Here, the longshore and cross-shore bathymetry become more complex (Figure P-1). The axis of the Loma Sea Valley lies about 15 km offshore, at a depth of about 370 m. Continuing offshore, the bottom rises sharply to a depth of about 145 m over the Coronado Escarpment, a narrow (ca. 3 km wide) finger of the mainland shelf extending up from the south. The center of the escarpment lies about 2 km offshore from the axis of Loma Sea Valley. Offshore from the Coronado Escarpment, the bottom plunges to a depth of about 1200 m in the San Diego Trough (ca. 23-38 km offshore). The north end of the Coronado Escarpment lies approximately offshore from the PLOO, then slopes downward to the north to intersect the mainland slope in about 800 m of water about 20 km farther north. At the south end of Point Loma, the coast breaks abruptly to the east forming a small bight. Immediately to the east of Point Loma, the coast is cut by the entrance to San Diego Bay.

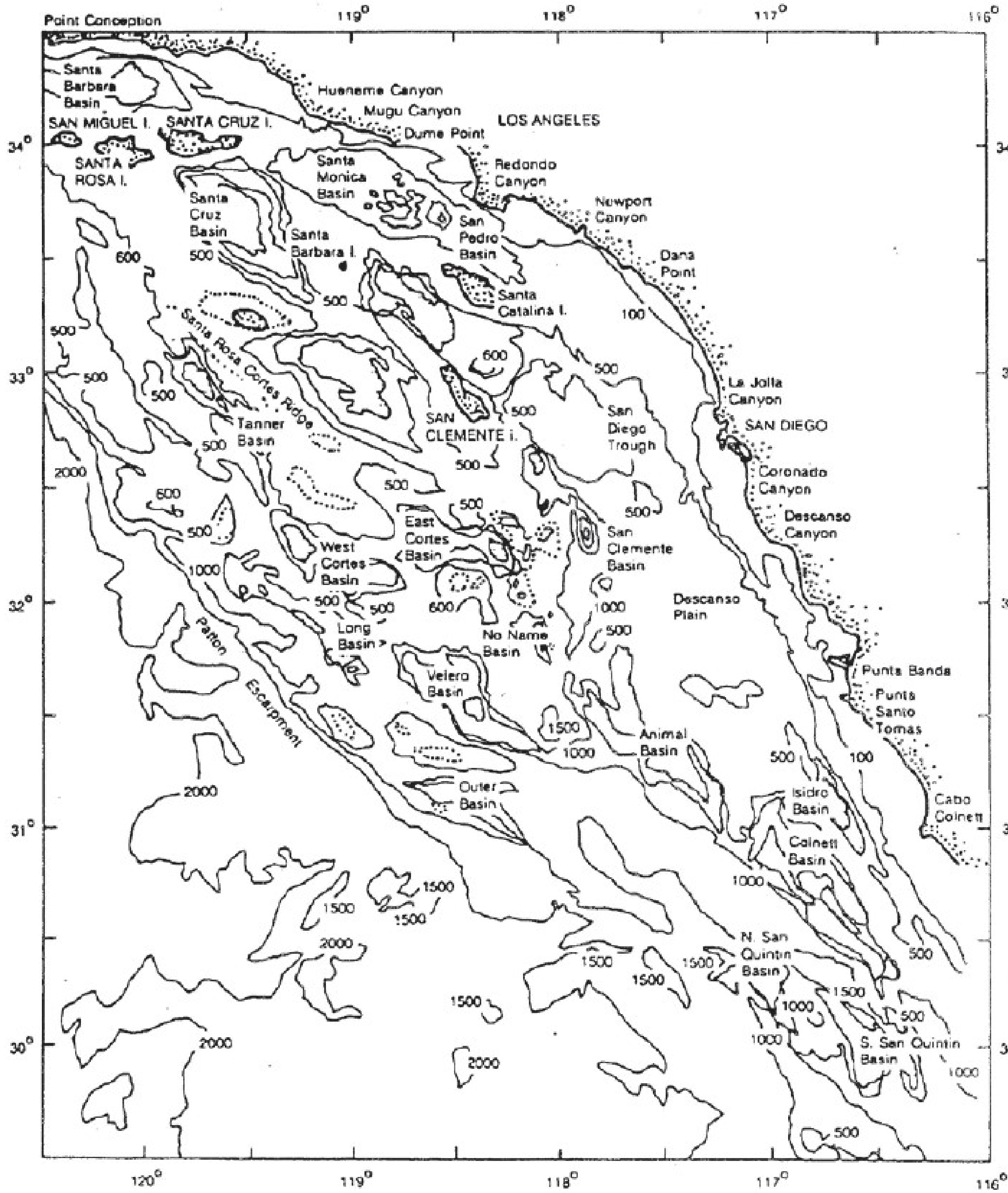

FIGURE P-1 Bathymetry of the Southern California Bight.

SECTION P-3 | CURRENTS

The complex bathymetry of the SCB plays an important role in the flow of ocean currents in this region. The most predominant current is the California Current, which is a broad (approximately 600 km wide), meandering, and diffuse southeastward flow along the west coast of the United States. It represents a continuation of the North Pacific Subarctic Drift and is part of the eastern portion of the North Pacific gyre. It consists of low temperature and low salinity water, with typically low surface flow speeds (10-20 centimeters (cm)/sec), which decrease to about 2 cm/sec at a depth of about 200 m. The maximum speeds are found about 300 km offshore and occur in the late summer (Hickey 1993). A seasonal surface counter-current of comparable speed is often present between the coast and the California Current (Figure P-2), which is strongest in the summer and autumn, and weak (even occasionally absent) in the winter and spring (SCCWRP 1973).

At depths in excess of 100 m off southern California, circulation appears to be less complex than in surface waters. The most distinctive characteristic is a northwestward subsurface flow (Jones 1971) on the shoreward side of the California Current (Hickey 1993). This California Undercurrent is narrower than the California Current, but appears to be present throughout the SCB (Hickey 1993). The seasonal maximum flow occurs in the late summer and early fall (Hickey 1993), slowing to its minimum flow in the spring. A second seasonal maximum in the early winter is present at most locations (Hickey 1993). Free circulation of this undercurrent within the SCB is limited by the bathymetry to depths shallower than about 350 m (Jackson 1986).

The net flow of currents over the nearshore shelf varies above and below the thermocline. Mean transport by the surface currents is typically southeastward during all seasons, although weakest in the fall (e.g., Winant and Bratkovich 1981). Net annual transport by the subpycnocline and/or subthermocline currents is typically northwestward with speeds on the order of a few cm/sec (Hendricks, 1977, 1980, 1986, 1990, 1992).

In the region surrounding the PLOO, mean current velocities from 2014 through 2020 ranged from a low of 5 to 17 cm/s, with the highest velocities typically occurring in surface waters during the spring (Appendix D). As has been observed elsewhere in the SCB, velocities decreased with depth, with the lowest mean velocities near the bottom of the PLOO (15 m from the seafloor). In regard to current direction, predominant flow followed a north-northwest/south-southeast axis of variation, regardless of season. Additionally, linear regression of all current direction observations for each depth generally show that along-coast currents tend to dominate. These results are consistent with observations at the PLOO by the City of San Diego, and with previous studies conducted in the region (Winant and Bratkovich 1981, Rogowski et al. 2012a).

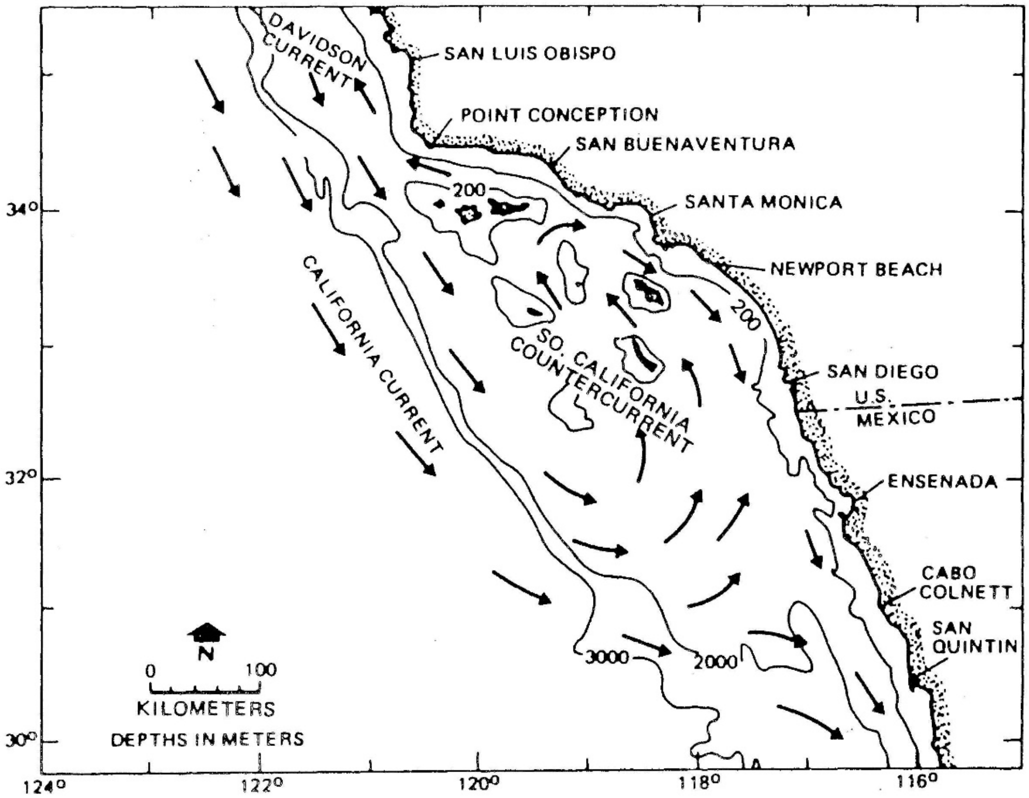

FIGURE P-2 Currents within the Southern California Bight.

SECTION P-4 | OCEAN CONDITIONS

(Temperature, Salinity, Dissolved Oxygen, pH)

Ocean conditions around the PLOO are generally consistent with large-scale temporal patterns in the California Current System (CCS) associated with ENSO, PDO and NPGO events (Peterson et al. 2006, McClatchie et al. 2008, 2009, Bjorkstedt et al. 2010, 2011, 2012, Wells et al. 2013, Leising et al. 2014, 2015, NOAA/NWS 2020). Thirteen major events have affected ocean conditions in SCB coastal waters during the last two decades: (1) the colossal El Niño of 1997 to 1998; (2) a shift to cold ocean conditions reflected in ENSO and PDO indices from 1998 to 2002; (3) a subtle, but persistent, return to warm ocean conditions in the CCS that began in October 2002 and lasted through 2006; (4) the intrusion of subarctic waters into the CCS that resulted in lower than normal salinities from 2002 to 2004; (5) development of a moderate to strong La Niña in 2007 that coincided with a PDO cooling event and a return to positive NPGO values indicating an increased flow of cold, nutrient-rich water from the north; (6) development of another La Niña starting in May 2010; (7) a region-wide warming, beginning in the winter of 2013/2014, when the PDO, NPGO and MEI (Multivariate ENSO Index) all changed phase; (8) an anomalous surface warm pool which extended across much of the NE Pacific from 2014-2015 (this warm pool, unique in the climate record of the NE Pacific, was coined the "Blob" and resulted from large scale wind patterns in the NE Pacific);

TABLE P-1
Minimum and maximum values for various oceanographic parameters for offshore samples collected by the City of San Diego Ocean Monitoring Program from 1994 through 2020.

Parameter	Min/Max	Sample Date	Value	Depth (m)	Season
Temperature (°C)	min	5/15/2000	9.00	98	spring
	max	8/10/2016	24.03	1	summer
Salinity	min	4/15/2004	32.41	1	spring
	max	4/15/2004	34.46	6	spring
DO (mg/L)	min	5/21/2003	1.51	99	spring
	max	5/6/2011	13.96	8	spring
pH	min	8/27/1998	7.30	97	summer
	max	8/9/2012	8.61	29	summer

(9) the colossal El Niño of 2015; (10) a weak La Niña in late 2016; (11) a second weak La Niña in late 2017 through early 2018; (12) a weak El Niño in late 2018 through mid-2019; and finally (13) the return of a marine heat wave in mid to late 2019 in the CCS.

Temperature and salinity data for the PLOO region have been generally consistent with the aforementioned large-scale events. Regardless of the year or season, water temperature shows a decrease throughout the water column with increasing depth. The warmest waters typically occur at the surface during the summer (up to 24.03 degrees Celsius (˚C) in 2016), while the coolest waters typically occur at depth during the spring (down to 9.0˚C in 2000), which aligns with the " spring transition" described by Huyer et al. (1979). Briefly, this transition occurs during the spring and summer when prevailing winds switch to blowing from the north (Huyer et al. 1979). Salinities also followed expected seasonal patterns, with the highest salinity values (up to 34.46 ppt in 2004) typically recorded at bottom depths (80 and 98-m stations) during spring, and lower salinity values (down to 32.41 ppt in 2004) recorded throughout the water column, particularly in surface waters during the winter (Table P-1).

Despite seasonal trends, there have been some notable deviations from SCB region-wide trends. For example, while the CCS was experiencing a warming trend through 2006, the PLOO region experienced cooler than normal conditions during much of 2005 and 2006. Additionally, conditions in San Diego waters during these years were more consistent with observations from northern Baja California where water temperatures were well below the decadal mean (Peterson et al. 2006). Ocean temperatures were also warmer than the long-term average during winter through summer 2016. These results corresponded to El Niño conditions that lasted until spring 2016 before switching to being relatively cool in November 2016, a pattern that corresponded well with a La Niña that lasted from late 2016 through winter 2017. Deviations from the long-term average were minor, reflecting the ENSO neutral conditions that endured for most of 2017 (NOAA/NWS 2020). Ocean temperatures observed throughout the water column were warmer than the historical average during most of 2018, and closer to average conditions during 2019 for the PLOO region in particular. In contrast, the CCS north of Monterey Bay showed surface water temperatures far above average in summer and fall 2019, consistent with a regionwide marine heat wave, as well as positive PDO and negative NPGO phases. Above average salinity observed during 2018 and 2019 was consistent with conditions all along the west coast, shifting from lower than normal salinities during the warm period of 2014–2016. These anomalous conditions were remotely observed moving towards the SCB prior to this time period, suggesting a shifting balance of water mass source waters being responsible for these temperature and salinity anomalies (Thompson et al. 2018, 2019).

Levels of dissolved oxygen (DO) and pH in the coastal waters off San Diego generally follow annual patterns that correspond to seasonal fluctuations in water column stratification. Furthermore, changes in DO and pH tend to be closely linked, since both parameters reflect fluctuations in dissolved carbon dioxide, an indicator of biological activity in coastal waters (Skirrow 1975). Concentrations of DO in the PLOO region have ranged from a low of 1.51-9.5 mg/L in winter/spring to 3.5-13.96 mg/L in the summer. The recorded pH has ranged from 7.30 to 8.61 in the summer (Table P-1). Maximum DO and pH are typically recorded in surface waters of the PLOO region during the summer during periods of high biological productivity. Whereas, minimum DO and pH are commonly observed in the deepest waters during the spring and summer, likely due to upwelling of cold, saline, oxygen-poor water moving inshore (Jackson 1986).

SECTION P-5 | STRATIFICATION

Ocean waters generally form stratified layers with less dense waters near the surface and denser waters at greater depth. Larger differences in density between layers provides greater stability that can suppress vertical water mixing that impacts the efficiency of vertical exchanges of heat, carbon, oxygen and other constituents. Across the SCB, the density structure of the water column plays an important role in the behavior of water masses. Magnitudes of the density gradients, in combination with current shear in the water column, also determine the rate of vertical mixing. This rate, in turn, affects the mixing of water masses, as well as changes in properties of the ocean currents, for example, influencing fluxes in dissolved oxygen.

In the PLOO region, seasonal changes in thermal stratification are mirrored by density stratification of the water column (Figure P-3). This relationship aligns with regional studies showing that density in shallow coastal waters of southern California, and elsewhere, is primarily influenced by temperature differences, since salinity is relatively uniform (Bowden 1975, Jackson 1986, Pickard and Emery 1990). The water column above the outfall is density stratified by gradients in temperature and salinity. However, salinity gradients are minimal for water temperatures above about 11-12°C, but increase significantly in lower water temperatures. The strongest density gradients exist during the summer in the upper portion of the water column due to the formation of a seasonal thermocline at depths that range from a few meters to a few tens of meters (typically around 5-20 m). These dynamics in the summer are sufficient to trap the plume at or below 30 m below the surface (City of San Diego 2015b). The situation is reversed in deeper water (depths in excess of about 45 m), where the strongest density gradients occur during the winter, however, these density gradients are weak in comparison with the gradients existing in the surface waters during the summer.

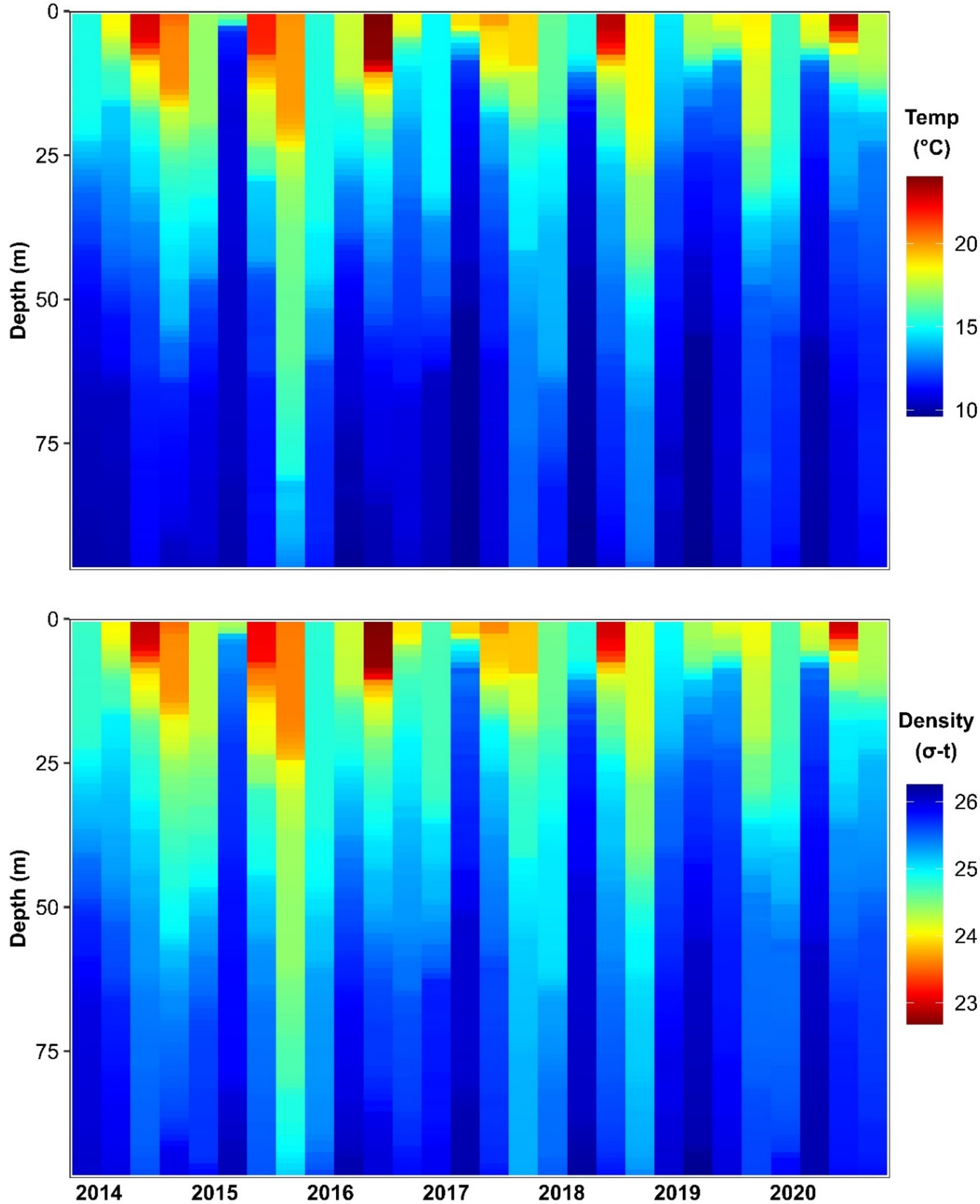

FIGURE P-3 Temperature and density at nearfield station F30 from 2014 through 2020.

Given the hydrographic conditions of Point Loma waters and the discharge characteristics of the outfall, the probability of the wastewater plume surfacing is highly unlikely. In fact, Rogowski et al. (2013) showed that the PLOO wastewater plume never surfaced, and its shallowest depth during the observational period was 35 m. This is also supported by satellite observations that do not show evidence of the PLOO plume surfacing (Appendix F) and aligns with the results of initial dilution simulation models, which show the shallowest depth of the plume to range from about 32 to 47 m (City of San Diego 2015b). Rogowski et al (2013) also observed that the plume was advected mainly alongshore with only two instances where the plume moved toward shore but shoaled in waters deeper than the nearshore kelp forest (~30 m). Inshore current observations indicate that upwelling circulation, of tidal period or longer, are mostly associated with southeastward movement of the plume, which implies that the PLOO wastewater plume is typically directed away from Point Loma and the kelp forest. Thus, wastewater from the PLOO is normally excluded from entering the nearshore and, rather, remains offshore at depths.

SECTION P-6 | INITIAL DILUTION

Initial dilution is defined by the California Ocean Plan (Ocean Plan) as "The process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge. For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally" (SWRCB 2015). The most protective Ocean Plan water quality objectives are based on preventing potential chronic impacts associated with long-term exposure of habitat or species to low levels of contaminants at and beyond the zone of initial dilution. The Ocean Plan objectives are conservatively based on ensuring that receiving water concentrations are less than the most stringent water quality criteria identified by EPA as being required to protect beneficial uses and endangered species. The combination of ocean currents, rate of effluent discharge from an outfall, and the design of outfall diffusers determine the magnitude of the initial dilution and the position of a wastewater plume in the water column.

In accordance with the Ocean Plan, National Pollutant Discharge Elimination System (NPDES) effluent concentration limitations for toxic constituents are back-calculated on the basis of an assigned "minimum initial dilution", which the Ocean Plan defines as the lowest monthly average initial dilution that occurs within any single month of the year. Back-calculating NPDES permit limits represents a conservative approach for preventing such chronic impacts, as average initial dilution at any given location over long periods of exposure would be higher than the average monthly value during minimum month conditions. Initial dilution for the PLOO was assessed using a U.S. Environmental Protection Agency (USEPA) modeling application, Visual Plumes (Frick et al. 2002). Using this approach, the current NPDES permit for the PLOO discharge establishes an average monthly initial dilution of 204:1 for minimum month conditions; this dilution ratio is based on an average monthly discharge rate of 205 million gallons per day (MGD). However, minimum dilutions that are measured, or estimated, at any given location, or time, in the vicinity of the PLOO discharge can be lower than 204:1 (Appendices Q, City of San Diego 2015a).

As the established NPDES initial dilution value is a minimum monthly value, this value cannot (and should not) be directly compared with instantaneous measurements of receiving water dilution. For example, Rogowski et al. (2012a) estimated "snapshot" minimum PLOO dilutions using measurements of colored dissolved organic matter (CDOM) from an autonomous underwater vehicle (AUV). While minimum "snapshot" dilutions reported by Rogowski et al. (2012a) using this CDOM approach ranged from approximately 100:1 to over 200:1, the minimum dilution estimates presented by Rogowski et al. (2012a) were not representative of minimum monthly average initial dilutions achieved by the PLOO, as they were based on minimum values recorded over a short period of several hours. Short-term variations in discharge conditions may cause observed minimum dilutions to appear lower than the average monthly value during minimum month conditions. Further, minimum dilutions estimated by Rogowski et al. (2012a) occurred at different locations during each date and AUV deployment. As a result, none of the minimum dilutions reported by Rogowski et al. (2012a) are reflective of long-term dilutions (i.e., those that resemble chronic exposure timeframes) at a particular location. Initial dilution may not have yet been completed at the time and location of all CDOM readings collected by Rogowski et al. (2012a). Thus, some of the reported minimum dilutions are lower than values that are achieved once initial dilution is completed, which is required by the Ocean Plan.

Dilution estimates reported by Rogowski et al. (2012a) assume no spatial variation in naturally occurring CDOM, though natural mechanisms (such as organic matter from the nearby Point Loma kelp bed) may result in this variation of ambient CDOM. If this occurs, actual PLOO dilutions achieved during the AUV deployment periods may have been higher than the CDOM-derived dilution estimates reported by Rogowski et al. (2012a). As a result of these factors, the current methodology set forth in the Ocean Plan represents the most reliable and appropriate means for ensuring that aquatic habitat and species are protected, and water standards are met through the development of ocean outfall effluent discharge limitations. In accordance with the Ocean Plan, effluent limitations are based on minimum month initial dilution derived from EPA approved and verified dilution models.

Though these models assume zero ocean currents in their calculations, currents play an important role in propagating and mitigating the effects of the discharge of wastewater from an ocean outfall. They are characterized by properties that change in time and space (Appendix D). In the immediate vicinity of the outfall (spatial-scales on the order of 1-2 km and time-scales ranging from minutes to hours), the strength and direction of the flow influence the magnitude of the initial dilution, as well as the rise height of the plume, and the spatial dimensions of the wastewater plume. In addition, the density structure of the water column plays an important role, where stronger density gradients impact both the entrainment region of the water column and the magnitude of initial dilution. Over long timescales (days to weeks) and large spatial-scales (5–50 km), currents determine the rate of flushing of wastewater out of the discharge area, and the renewal of effluent-free ambient water.

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APPENDIX Q

INITIAL DILUTION SIMULATION MODELS

City of San Diego
Public Utilities Department

March 2022

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Acronyms and Abbreviations

ADCP	acoustic Doppler current profiler
AUV	autonomous underwater vehicle
CDOM	colored dissolved organic matter
City	City of San Diego
cm	centimeters
CTD	conductivity, temperature, and depth
EPA	United States Environmental Protection Agency
m	meters
m^3/sec	cubic meters per second
mgd	million gallons per day
mL	milliliters
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan, Ocean Waters of California
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
ROTV	remotely operated towed vehicle
RWQCB	California Regional Water Quality Control Board, San Diego
SWRCB	State Water Resources Control Board
ZID	zone of initial dilution

OVERVIEW

This appendix summarizes the basis for the 204:1 minimum month initial dilution value designated within Order No. R9-2017-0007. This 204:1 minimum month initial dilution value is based on modeling work presented in the City of San Diego's (City's) original 1995 301(h) application for the Point Loma Ocean Outfall (PLOO) discharge. Sections Q.2 through Q.4 of this appendix present the results of this original 1995 modeling work as originally presented in the City's 1995 301(h) application. For comparison, Section Q.5 of this appendix summarizes subsequent modeling conducted by the City and by the United States Environmental Protection Agency (EPA) and the California Regional Water Quality Control Board, San Diego (RWQCB) which projected initial dilutions in excess of the 204:1 initial dilution value assigned in Order No. R9-2017-0007. Section Q.6 of this Appendix presents a brief review of PLOO plume tracking studies and enterococcus data that (1) demonstrate consistency with the assigned 204:1 initial dilution and (2) confirm that the 204:1 minimum month initial dilution value remains appropriate for protecting beneficial uses.

ABSTRACT

This appendix summarizes the basis for the 204:1 initial dilution value designated within Order No. R9-2017-0007 for the PLOO discharge. This 204:1 minimum month initial dilution value is based on modeling originally presented in the City's 1995 301(h) application for the PLOO discharge.[1] Sections Q.2 through Q.4 of this appendix present the 1995 modeling results originally presented in the City's 1995 301(h) application, which utilized the RSB-TSI initial dilution model. The RSB-TSI model is a derivative of the BASIC RSB simulation model developed by Roberts (Baumgartner et al., 1993) and is modified based on additional work reported by Roberts et al. (1989a, 1989b, 1989c). As part of the 1995 modeling effort (presented herein), both hydrocast data and time-series measurements of water column density structure and currents were used to predict the initial dilutions achieved by the PLOO.

Discharge flow rates of 240 and 205 million gallons per day (mgd) were assessed as part of the 1995 modeling effort.[2] The 240 mgd flow represents the monthly average design flow for the Point Loma Wastewater Treatment Plant (PLWTP). The 205 mgd flow represents the average annual 301(h) variance flow addressed within Order No. R9-2017-0007 (National Pollutant Discharge Elimination System (NPDES) CA0107409).[3]

1 The 1995 modeling effort was presented within Appendix O of City of San Diego 301(h) Application for Modification of Secondary Treatment Requirements Point Loma Ocean Outfall (April 1995).

2 For comparison, PLWTP flows during calendar year 2020 averaged 143.3 mgd.

3 A secondary treatment variance for total suspended solids was granted by EPA within Order No. R9-2017-0007 on the basis of an annual average PLOO discharge flow of 205 mgd. See Finding II.D (page 4) of Order No. R9-2017-0007.

For an annual average flow rate of 205 million gallons per day (mgd), the median flux-averaged PLOO initial dilution was projected at 365:1 using the RSB-TSI model. Using hydrocast data as input, the lowest monthly average initial dilution in the absence of currents (as defined by the Ocean Plan[4]) was 204:1. Using time-series data as input, the lowest monthly average initial dilution (as defined by the Ocean Plan) was computed at 238:1. At the 240 mgd design PLWTP capacity, the projected initial dilution was approximately 7% less than the dilution projected for the 205 mgd flow rate. Since present day average annual PLOO discharge flows remain significantly lower than the 205 mgd flow projected in the 1995 301(h) application, the modeling projections of 1995 remain valid as a tool for projecting worst case PLOO minimum month initial dilutions.

This appendix also summarizes (see Section Q.5) subsequent modeling conducted by the City and by the EPA and the RWQCB using the updated EPA Visual Plumes model. This updated modeling determined higher minimum month dilution values than the 204:1 value assigned in Order No. R9-2017-0007. Additionally, this appendix (see Section Q.6) presents a brief review of PLOO plume tracking studies and enterococcus data that demonstrate consistency with the assigned 204:1 initial dilution. The findings presented herein demonstrate that the 204:1 minimum month PLOO initial dilution assigned in prior NPDES permits remains valid and represents a conservative approach for protecting ocean water quality and beneficial uses. To assure conformance with antidegradation and anti-backsliding requirements, the City proposes continuation of EPA/RWQCB approach employed within Order No. R9-2017-0007 of:

- utilizing a 205 mgd flow as the basis for assessing PLOO initial dilution, and
- retaining the 204:1 initial dilution value that has been assigned as part of each of the prior PLOO 301(h) discharge permits.

Q.1 INTRODUCTION

Initial Dilution and Ocean Plan Requirements

The *Water Quality Control Plan, Ocean Waters of California* (Ocean Plan) establishes receiving water quality objectives for the protection of aquatic habitat and beneficial uses.[5] Ocean Plan receiving water quality objectives are to be achieved after completion of initial dilution. The Ocean Plan defines initial dilution as the "process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge." For buoyant submerged discharges, the Ocean Plan considers initial dilution to be completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally. The Ocean Plan further specifies that effluent concentration limits to implement the Ocean Plan receiving

4 Water Quality Control Plan Ocean Waters of California (Ocean Plan). The most recent version of the Ocean Plan was adopted by the State Water Resources Control Board (SWRCB) on August 7, 2018 and became effective on February 4, 2019.

5 Receiving water quality objectives established in Table 3 of the Ocean Plan have been adopted by EPA as representing federal water quality standards enforceable under the Clean Water Act.

water quality objectives are to be determined through the use of the following equation[6]:

$$C_e = C_o + D_m(C_o - C_s) \qquad Equation\ Q-1$$

Where C_e = the effluent concentration limit in µg/L,

C_o = the Ocean Plan receiving water objective (concentration in µg/L) to be met upon completion of initial dilution,

D_m = the minimum probable initial dilution (expressed as part seawater to parts wastewater), defined by the Ocean Plan as the lowest monthly average initial dilution achieved during any month of the year, and

C_s = the background seawater concentration (designated by the Ocean Plan as zero except for arsenic, copper, mercury, silver and zinc).

Provision III.C.4.e of the Ocean Plan provides that the minimum month average initial dilution (D_m) is to be determined using approved computer models, as follows:

III.C.4.e The Executive Director of the State Water Board shall identify standard dilution models for use in determining D_m, and shall assist the Regional Board in evaluating Dm for specific waste discharges. Dischargers may propose alternative methods of calculating D_m, and the Regional Board may accept such methods upon verification of its accuracy and applicability.

Physical Process of Initial Dilution

The PLOO discharges warm, low salinity effluent[7] into southern California coastal ocean waters at a depth of about 93 meters (m). The discharge is a source of both kinetic energy (associated with the momentum of the jet of water from the diffuser port) and potential energy (due to buoyancy of the effluent in sea water). Shear driven by the energy input results in the entrainment of ambient ocean water into the wastewater plume. The bulk of this entrainment is driven by the buoyancy of the effluent, with the initial jet momentum (velocity-based) mixing playing a secondary role. The reduction in the concentration of effluent within the plume as the result of this mixing is known as *initial dilution*.

In the absence of ocean currents, the initial jet-induced mixing from a port discharging horizontally is followed by a buoyancy-driven transition to a nearly vertical buoyant rising plume. If the receiving water is not density stratified (or if the stratification is very weak), the plume will rise to the surface and the effluent sea water mixture will spread out to form a horizontal wastefield. In general, any additional mixing subsequent to this transition from a plume to a wastefield is slow compared with the mixing into the rising plume. The initial dilution process is considered to be complete when the buoyant rise of the plume ceases.

6 See Equation 1, page 16 of the 2019 Ocean Plan.

7 Concentrations of total dissolved solids (TDS) in the PLOO discharge during 2020 ranged from 1520 to 1850 milligrams per liter (mg/L). For comparison, seawater TDS concentrations are typically on the order of 33,000 mg/L.

Under typical conditions where the water column is density stratified, the deep ambient water entrained into the plume will be denser than the ambient water entrained into the plume at shallower depths. For sufficiently strong stratification, enough dense ambient water can be entrained into the plume during its rise so that at some depth the density of the water in the plume becomes equal to the density of the surrounding ambient water. When this occurs (which is typical), all diluted effluent remains submerged.

The magnitude of the initial dilution depends on the design of the outfall and the characteristics of the receiving water environment. Increasing the density difference between the discharged effluent and the receiving water increases the buoyant energy and hence the mixing. Increasing the interface area between the plume and surrounding receiving water (e.g., by increasing the length of the diffuser and the number of ports, and reducing port diameters) promotes entrainment and increases the initial dilution. Conversely, an increase in the discharge rate requires an increased entrainment across the interface to achieve the same dilution, hence the initial dilution may be reduced. Increased density stratification of the water column reduces the height of rise of the plume, reducing the interface area and the initial dilution.

The mixing process becomes more complicated in the presence of ocean currents. The flow of ambient water past the diffuser changes the current shear and also generates a pressure difference between the upstream and downstream faces of the plumes from the diffuser. This causes the plume to deflect in the direction of the prevailing current. This has two potentially important consequences: (1) the lateral extend of the discharge plume is increased and (2) vertical mixing (across the plume) can be affected. Since the density of the rising plume is less than the surrounding water, the upper interface between the plume and the receiving water is gravitationally unstable, and vertical mixing is enhanced (conversely, vertical mixing is suppressed on the lower interface). At low speeds, these current-induced effects are small. However, a threshold speed exists at which these effects become important, resulting in an increase in initial dilution compared with the dilution of the same discharge in the absence of ocean currents. The magnitude of this threshold speed depends on the design of the diffuser, discharge rate of effluent, effluent-receiving water density difference, the speed of the current, and the current direction relative to the alignment of the diffuser.

A number of numerical models have been developed to relate the characteristics of the initial dilution process to the diffuser design, discharge rate, effluent density, and the properties of the receiving water environment (e.g., density, density gradient, ocean currents). The numerical models have been developed from a mixture of theoretical principals, heuristic methods, and physical model studies of the initial dilution process. The hydrodynamics of the entrainment process in a density stratified, moving ocean are complex and the characteristics of the receiving water change with time, depth, and position. Thus, a large number of parameters are required to completely describe the initial dilution process. Every simulation model has some limitations in its range of application. It is important to identify and assess these limitations in selecting a dilution model for a particular outfall site and set of discharge conditions.

Initial Dilution Definitions

A number of definitions of dilution and initial dilution are in common use. For example, EPA defines dilution (S) as the reciprocal of the volume concentration (fraction) of effluent (C_e) in the plume (S = 1/C_e). Thus, pure effluent has both a concentration and a dilution of unity. In contrast, the Ocean Plan defines dilution as the volume of diluting ocean water mixed with a unit volume of discharged effluent, where the concentration of effluent is related to the dilution through the equation:

$$C_e = \frac{1}{1+S} \qquad \text{Equation } Q-2$$

Initial dilutions resulting from the extended PLOO are in excess of 100:1 at all times. Consequently, for the PLOO the two definitions of dilution differ by less than 1%. This difference is less than the typical 10-15% uncertainties that exist in most simulation model predictions.[8] Hence, for all practical purposes the two definitions can be used interchangeably.

The Ocean Plan presents definitions for the synonymous terms "minimum probable initial dilution", "minimum initial dilution", "lowest average initial dilution within any month", but the type of averaging associated with these terms is not clearly expressed. Within this appendix, the term “concentration” refers to the concentration of effluent, averaged over a sufficient period of time, so that fluctuations associated with turbulent mixing are reduced to an insignificant level. Typical averaging times for a sample collected at some point within the plume are on the order of minutes to tens of minutes. The term “dilution” refers to the inverse of the concentration. The term “minimum dilution” refers to the dilution associated with the highest concentration within the plume/wastefield at the completion of the initial dilution process.

Within this appendix, the term “initial dilution” refers to the flux-averaged dilution, S_{fa}. The flux-averaged dilution is related to the flux-averaged concentration across a section of the wastefield. The latter is computed by weighting the concentration of effluent at some location, z, within the wastefield, $C(z)$, by the discharge-induced velocity of flow, $v(z)$ at that elevation:

$$\frac{1}{S_{fa}} = C_{fa} = \frac{\int_{z_1}^{z_2} C(z)v(z)dz}{\int_{z_1}^{z_2} v(z)dz} \qquad \text{Equation } Q-3$$

The flux-averaged initial dilution is equivalent to the volumetric dilution, (i.e., the total volume of ambient water to the volume of effluent in the wastefield). The volumetric initial dilution is often required to demonstrate regulatory limitations on contaminant concentrations in receiving waters. For example, effluent concentration limitations required to implement Ocean Plan Table 3 receiving water quality objectives (to be achieved upon completion of initial dilution) are computed using a volumetric (i.e., flux-averaged) initial dilution.

Minimum initial dilution (as the term is used herein) is defined as the smallest flux-averaged initial dilution value among a set of flux-averaged initial dilution values. Note that this term (minimum initial dilution) differs from the Ocean Plan-defined terms “minimum probable initial dilution” and “lowest average initial dilution within any month” which are averaged over

8 Reference: Roberts et al., 1989a.

conditions of a "minimum month".

Average initial dilution, S_a, is most commonly used to refer to the average of a set of individual initial dilution values. The averaging is usually carried out for some period of time, such as a monthly average initial dilution. Note, however, that both the term "average initial dilution" and the notation, S_a, are used in Roberts et al. (1989a) to denote the spatially-averaged dilution across the plume/wastefield:

$$\frac{1}{S_{sa}} = C_{sa} = \frac{\int_{h_{low}}^{h_{up}} C(z)dz}{\int_{h_{low}}^{h_{up}} dz} \qquad \textit{Equation } Q-4$$

The lower and upper bounds of the wastefield, h_{low} and h_{up}, are not well defined by state or federal regulations or guidance. For practical purposes, they are often selected to correspond to the upper and lower edges of the wastefield, where the effluent concentrations are equal to 5% of the maximum concentration.[9]

In the present application, use of the term "average initial dilution" is limited to the temporal average of a set of initial dilutions. Any references to the spatially-averaged initial dilution are specifically referred to as the spatially-averaged initial dilution, and denoted by S_{sa}. The term "minimum average initial dilution" is used herein to mean the smallest value among a set of average monthly initial dilutions. This term corresponds to the Ocean Plan-defined term "minimum probable initial dilution," which is defined as the "lowest average initial dilution within any month."

The most realistic simulation model estimates of the concentrations and dilutions achieved at the end of the initial dilution process are obtained using simultaneous measurements of the density structure of the water column and the ocean currents within the entrainment region of the plume. However, this information is frequently not available, and the data consists of measurements of the density structure and ocean currents taken at different times. In this case, any correlations between the strength and direction of the currents and the density stratification of the water column are not known. Perhaps because of this, the Ocean Plan takes a conservative approach in estimating initial dilutions by requiring that:

> *Dilution estimates shall be based on observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents of sufficient strength to influence the initial dilution process, flow across the discharge structure.*[10]

The resulting initial dilutions are commonly referred to as "zero current" initial dilutions. Initial dilutions meeting this criterion are obtained in the RSB numerical model simulations by setting the ambient current speed to be zero (or sufficiently small so that they lie below the threshold value for enhanced dilution).

9 Reference: Roberts et al., 1989.

10 See Section III.C.4.d (page 17) of the 2019 Ocean Plan (SWRCB, 2019).

In order to distinguish the initial dilution values associated with the artificial requirement of zero currents from the set of initial dilution values associated with the actual currents, initial dilutions obtained by setting the current speed to zero are hereinafter referred to as regulatory initial dilutions. Thus, based on the previously presented definitions, initial dilution as defined within the Ocean Plan is referred herein as the "regulatory minimum month average initial dilution."

Q.2 DESCRIPTION OF 1995 RSB-TSI INITIAL DILUTION MODEL

This section describes initial dilution modeling presented in the City's original 1995 301(h) application which continues to provide the basis for the 204:1 initial dilution value designated within Order No. R9-2017-0007.

Rationale for Selection of RSB-TSI Initial Dilution Model

Initial dilutions were computed as part of the 1995 modeling effort using the RSB-TSI initial dilution model, which is based on the physical model initial dilution studies reported by Roberts et al. (1989a, 1989b, 1989c), and is a derivative of the BASIC RSB simulation model written by Roberts (Baumgartner et al., 1993). Another version of the RSB model (EPA-RSB) is available in the EPA PLUMES initial dilution simulation package (Baumgartner et al., 1993, 1994). The principal changes in the EPA-RSB model from the BASIC RSB model are:

1. A change in the programming language from BASIC to PASCAL.
2. Adaptation of the BASIC RSB computational kernel to the PLUMES package interface and file structure.
3. Termination of the iterative scheme used within the kernel to obtain a solution if the number of iterations exceeds some specified number of iterations.

The RSB-TSI initial dilution simulation model was selected for the simulations because:

1. The RSB model (as well as the UM model) was recommended by Baumgartner et al. (1993) for multiport outfalls discharging buoyant sewage wastes into stratified saline waters, who states: "*In general, we believe RSB...is applicable to any case that matches closely the experimental conditions used in its development, which were limited to multiport discharges*." As will be shown later, the range of parameter values in the simulations for the extended PLOO fall within the range of values examined in the development of the model. The principal difference between the model study and the Point Loma conditions is that the density gradient generally varies with depth in the ocean, while a constant density gradient was examined in the laboratory model studies. Roberts allowed for the case of a variable density gradient in the BASIC RSB model, and each of the two derivatives of this model that were used to compute the initial dilutions utilize his approach. As will be discussed later, the effect of his approximation is to tend to underestimate the initial dilution and the height-of-rise of the plume in the water column.
2. Although both the UM and RSB models are appropriate for multiport discharges in the presence of currents, only RSB model (and its derivatives) can provide estimates of the initial dilution and a spatial description of the wastefield when the flow is within 45

degrees of the alignment of the diffuser. Since this "along diffuser" flow dominates at the Point Loma discharge, the RSB model represents an appropriate selection for assessing PLOO initial dilution.

The RSB-TSI simulation model was also chosen for the 1995 initial dilution simulations over the BASIC-RSB and EPA-RSB models based on the volume of input data available for the simulations. At the time the 1995 modeling was performed, two different sets of Point Loma oceanographic data were available for use in computing initial dilution. The first data set consisted of water column density stratification data collected during hydrocast surveys with a CTD (conductivity, temperature, and depth) recorder. These data were available at roughly monthly intervals from special studies (predesign and pre-discharge) made in the vicinity of the extended PLOO between February 1990 and October 1993 and from monthly monitoring data collected after commencement of the PLOO discharge. The second set of oceanographic data consisted of approximately 287 days (13,760 observations) of simultaneous measurements of water column temperatures and currents at a station close to the terminus of the extended PLOO collected between March 1990 and April 1991. Each of these data sets were collected prior to construction of the PLOO extension, and this are representative of receiving water conditions not affected by or influenced by the PLOO discharge.

Additional reasons for selecting the RBS-TSI model instead of the EPA-RSB and the BASIC-RSB initial dilution models included:

1. The large number of observations available for the simulations was not efficiently stored in the file structure used in the BASIC RSB model. The file structure used by the EPA-RSB model was in an undocumented binary format. In addition, oceanographic density data was available at nineteen to twenty depths in the water column, which exceeded the storage allotted within in the EPA-RSB model.
2. The receiving water density structure existing off Point Loma often resulted in the BASIC-RSB program failing to iteratively converge to a solution.
3. The density structure in the PLOO water column occasionally caused inaccuracies in the simulation output of the EPA-RSB model.
4. Neither the BASIC-RSB nor the EPA-RSB model provided for the automatic processing of an extensive set of simulation cases.
5. The format of the output generated by the RSB-TSI model could be tailored to fit simulation needs for use in subsequent simulations that build on the results of the initial dilution calculations.

Differences between RSB-TSI and BASIC RSB Models

The RSB-TSI model is based on the computational kernel in the BASIC-RSB model. This kernel uses an iterative method to obtain a solution to the initial dilution process for each set of discharge and receiving water conditions. The steps in this iterative process are:

1. A trial height-of-rise to the top of the wastefield (above the diffuser port) is selected. The initial trial value is set equal to the depth of the diffuser port below the sea surface.
2. The average density gradient of the receiving waters between the diffuser port and the trial height-of-rise is computed.
3. This "constant" density gradient is combined with the discharge characteristics (e.g., flow rate, effluent density), diffuser characteristics (port diameter, port spacing, number of ports), and ocean current strength and direction of flow (relative to the diffuser) to predict a height-of-rise to the top of the wastefield.
4. The magnitudes of the trial and the predicted heights-of-rise are compared.
5. If the trial and the predicted heights are within 1% of each other, a solution has been obtained and the height-of-rise to the top of the wastefield is known. The rest of the initial dilution characteristics (e.g., magnitude of the minimum initial dilution, wastefield thickness, height-of-rise to level of minimum dilution, and downstream distance to completion of the initial dilution process) are then computed.
6. If the two heights-of-rise are not the same, a solution has not been obtained and a new iteration is executed. A new trial height-of-rise is computed for this iteration and steps 2 through 6 are repeated.

It was found that the computational kernel in the BASIC-RSB model often failed to converge on a solution. Examination of the program revealed that the program became caught in an infinite loop in which a sequence of trial and predicted heights-of-rise were repeated without any convergence toward a solution. The EPA-RSB model (Baumgartner et al., 1993, 1994) avoids this "lock-up" problem by terminating the iteration process if the solution fails to converge. After exiting the iterative loop, the tentative solution is output with a warning that the results are suspect.

Baumgartner et al. (1994) noted that the iteration technique was changed between the 2nd and 3rd editions to "...converge faster and more regularly." The 3rd edition of the modal also issued a warning if convergence is not attained. Various methods of selecting an updated trial solution in the BASIC-RSB iterations were attempted as part of the 1995 PLOO modeling effort, but none of the methods guaranteed an acceptable solution for all input oceanographic data. It was thus concluded that the desired modeling accuracy and convergence criteria could not be achieved by simply modifying the BASIC-RSB iterative process.

As a result, a different solution method, as well as a different file structure, was used in the 1995 RSB-TSI initial dilution simulation effort. To implement this solution, the principal changes in the RSB-TSI model from the BASIC RSB model were:

1. A change in the programming language from BASIC to FORTRAN.

2. Replacement of the BASIC RSB input data and file structure by a file structure designed to interface with the time-series of oceanographic data (temperature and currents). The output file structure was also adapted to provide output data specific to the application of the modeling results.
3. A change in the method of solution within the computational kernel. The iterative approach used in the BASIC-RSB and EPA-RSB models was replaced by an incremental method.
4. Animation was added to the program output in order to illustrate characteristics of each initial dilution (magnitude, spatial dimensions), the convergence to the height-of-rise solution, the current strength and direction (relative to the diffuser), temperature stratification of the water column, and a set of bar graphs indicating the magnitudes of various parameters that describe the hydrodynamic characteristics of the initial dilution process.

The incremental solution method was analogous to the original BASIC-RSB iterative approach, except that:

1. The initial trial value is selected to be a small distance above the diffuser port (3 m in the Point Loma simulations).
2. A solution is achieved when the difference between the trial and predicted heights-of-rise is less than some specified distance (10 centimeters (cm) in the Point Loma simulations).
3. If a solution is not achieved, the new trial value is set equal to the previous trial value plus the test distance specified in step 2 (i.e., 10 cm at Point Loma). This is in contrast to the iterative approach, which computes a new trial value from a weighted combination of the previous trial value and the associated predicted value.
4. This process is repeated until a solution is achieved, or until the trial height-of-rise is equal to the depth from the diffuser port to the sea surface. If a solution still has not been obtained in the latter case, the solution height-of-rise is set equal to the average of the trial and predicted values that had the smallest difference. The difference between the trial and predicted heights-of-rise is stored in one of the output files and is flagged so these cases can be examined and removed from the output data, if desired.

In cases where the iterative approach converges to a solution, the predictions from the BASIC-RSB model and the RSB-TSI model are essentially the same. However, small differences can exist in the predicted heights-of-rise since the BASIC-RSB model solution (and, it is assumed, the EPA-RSB model) requires that the trial and predicted values differ by less than 1%, while the RSB-TSI model requires that the two values differ by less than a specified distance. This distance was 10 cm for the Point Loma simulations, so the RSB-TSI convergence requirement is more restrictive when the height-of-rise to the top of the wastefield exceeds 10 m (>99% of the cases). A comparison between the heights-of-rise and initial dilutions predicted by the BASIC-RSB model and the RSB-TSI model for a set of identical input conditions is presented later in this appendix.

Conservative Modeling Assumptions

A number of conservative assumptions were incorporated within in the BASIC-RSB and RSB-TSI initial dilution models which were designed to underestimate the initial dilutions actually achieved by the discharge. Three of these assumptions are:

1. On the average, the density gradient in the receiving waters below the seasonal thermocline increases with decreasing depth in the water column. The BASIC-RSB, EPA-RSB, and RSB-TSI models all assume that the density gradient is constant ("linear density profile") over the rise height to the top of the wastefield. Baumgartner et al. (1993) concluded from examining studies reported in Roberts (1993) that: "*... this (linearization) is a conservative assumption, as linear stratifications lead to less rapid spreading, thinner wastefield, less subsequent mixing, and, therefore, less dilution than in a wastefield at the same rise height in a non-linear stratification.*" The ratios of the predicted to the measured minimum initial dilution reported by Roberts (1993) for four discharge scenarios (3 discharge rates, 1 case with and without ambient currents), varied from 0.82 to 0.96 (average: 0.86 ±0.07).

2. The RSB physical model studies examined initial dilution for flow perpendicular, parallel, and at a 45-degree angle to a linear diffuser. The extended PLOO terminates in a diffuser consisting of two legs forming a wide "V" (a "bent" line source). Ocean currents will generally flow across the two legs at different angles. This difference in angles has no effect on the initial dilutions if the Froude number is less than 0.1. At higher Froude numbers, all other conditions being equal, the diffuser leg oriented with the smallest angle to the flow will have the lowest initial dilutions. In the RSB-TSI model, a user selectable option forces the simulation to select the diffuser leg with either the: (1) smallest or, (2) largest angle to the flow (the actual leg will change from case to case as the direction of the flow changes). The initial dilutions in this application were generated for the leg with the smallest angle, thus the predicted initial dilutions will tend to underestimate the dilution for the combination of the two legs.

3. The flux-averaged initial dilution is difficult to measure directly. Based on estimates of entrainment flows measured outside the plume in laboratory studies, Roberts (1989) concluded that the flux-averaged initial dilution is approximately 1.15 times greater than the minimum initial dilution. To be conservative, the 1995 RSB-TSI modeling effort assumed a ratio of 1.21 between the flux-averaged initial dilution and minimum initial dilution. While this ratio is predicted to decline as the ambient flow increases, the relationship between this ratio and discharge flow cannot be accurately estimated. As a result, this 1.21 ratio was used for the range of assessed PLOO discharge flows. It is probable that use of this 1.21 ratio resulted in increased underestimation of PLOO initial dilution as PLOO discharge flows increase.

Q.3 INPUT DATA FOR 1995 RSB-TSI INITIAL DILUTION MODEL

The input data required for the 1995 initial dilution simulations consisted of three types: (1) data values or parameters that remain constant, (2) values that are cyclic, and (3) values that are not cyclic, although fluctuations associated with a number of time-scales may be evident.

Type 1 Input Data - Constants

The first type of data includes the characteristics of the diffuser, including:

- the number of ports,
- port configuration,
- port diameter(s),
- port spacing,
- port depth(s) below the surface,
- alignment of the diffuser leg(s), and
- the annual average discharge rate.

The values of these parameters that were used in the 1995 RSB-TSI initial dilution simulations are summarized in Table Q-1.

Two PLOO discharge flows were assessed in the 1995 RSB-TSI model. The discharge rate of 240 mgd corresponds to the maximum annual average design flow of the PLWTP. The discharge rate of 205 mgd represented the maximum annual average flow anticipated during the five-year period following issuance of the original 1995 PLOO 301(h) NPDES permit. This 205 mgd flow has been utilized for purposes of establishing mass emission limits and as a benchmark for antidegradation compliance in all prior PLOO 301(h) NPDES permits, including the current Order No. R9-2017-0007 (NPDES CA0107409).

Type 2 Input Data - Cyclic Variations

Examples of the second type of data include diurnal and seasonal variations in the discharge rate and the effluent density. Annual hydrographs and monthly variations in PLOO effluent density are presented in Table Q-2. The daily hydrographs used in the simulations are presented in Table Q-3.

Table Q-1:
Initial Dilution Model Input Type 1 Data - Constants

Parameter	Value
Number of Ports	416
Port Configuration	Paired on opposite side of diffuser
Port spacing	7.33 m
Nominal port diameter	0.108 m
Nominal port depth	93.7 m
Diffuser alignment (deg. true)	1900, 3450
Annual average discharge rate (waiver)	205 mgd (8.98 cubic meters per second (m^3/sec))
Annual average discharge rate (max. design)	240 mgd (10.51 m^3/sec)

Table Q-2:
Initial Dilution Model Input Annual Hydrograph and Effluent Density

Month	Ratio of Observed Monthly PLOO Flow to Average Annual Flow [A]	Observed Average PLOO Effluent Density [B] (sigma-t)
January	1.139	-1.878
February	1.076	-2.022
March	1.061	-2.313
April	0.976	-2.692
May	0.950	-2.989
June	0.958	-3.279
July	0.966	-3.578
August	0.984	-3.648
September	0.980	-3.097
October	0.990	-2.910
November	0.969	-2.228
December	0.951	-2.767

Table Q-2 Notes:

A. Based on historic PLOO data which is projected to be characteristic of future flow trends.

B. Based on historic PLOO temperature and salinity data which are projected to be characteristic of future fluent quality.

Table Q-3:
Initial Dilution Model Input - Daily Flow Hydrograph

Time Period	Ratio of Instantaneous Flow to Monthly Average Flow [A]	
	205 mgd	240 mgd
00:00 - 00:30	1.073	0.917
00:30 - 01:00	1.073	0.917
01:00 - 01:30	1.073	0.917
01:30 - 0200	1.073	0.917
02:00 - 02:30	0.756	0.646
02:30 - 03:00	0.756	0.646
03:00 - 03:30	0.756	0.646
03:30 - 04:00	0.756	0.646
04:00 - 04:30	0.756	0.646
04:30 - 05:00	0.463	0.646
05:00 - 05:30	0.463	0.646
05:30 - 06:00	0.463	0.375
06:00 - 06:30	0.463	0.375
06:30 - 07:00	0.463	0.375

Time Period	Ratio of Instantaneous Flow to Monthly Average Flow[A]	
	205 mgd	240 mgd
07:00 - 07:30	0.463	0.646
07:30 - 08:00	0.463	0.646
08:00 - 08:30	0.756	0.646
08:30 - 09:00	0.756	0.912
09:00 - 09:30	0.915	0.912
09:30 - 10:00	1.073	0.912
10:00 - 10:30	1.073	1.167
10:30 - 11:00	1.390	1.167
11:00 - 11:30	1.390	1.167
11:30 - 12:00	1.390	1.354
12:00 - 12:30	1.390	1.354
12:30 - 13:00	1.390	1.354
13:00 - 13:30	1.390	1.530
13:30 - 14:00	1.390	1.521
14:00 - 14:30	1.390	1.521
14:30 - 15:00	1.390	1.521
15:00 - 15:30	1.073	1.354
15:30 - 16:00	1.073	1.354
16:00 - 16:30	1.073	1.354
16:30 - 17:00	1.073	1.354
17:00 - 17:30	1.073	1.354
17:30 - 18:00	1.073	1.167
18:00 - 18:30	1.073	1.167
18:30 - 19:00	1.073	1.167
19:00 - 19:30	1.073	1.167
19:30 - 20:00	1.073	1.167
20:00 - 20:30	1.073	1.167
20:30 - 21:00	1.073	1.167
21:00 - 21:30	1.073	0.917
21:30 - 22:00	1.073	0.917
22:00 - 22:30	1.073	0.917
22:30 - 23:00	1.073	0.917
23:00 - 23:30	1.073	0.917
23:30 - 00:00	1.073	0.917

Table Q-3 Notes:

A. Daily flow hydrograph relative to monthly average flow. Based on historical; PLOO flow trends.

Type 3 Input Data - Oceanographic Measurements

The third category of input data include (1) oceanographic data characterizing the density structure of the water column, and (2) the direction and magnitude of ocean currents. Two types of information on the density stratification of the water column were available for the Point Loma initial dilution simulations: hydrocast data and time-series temperature data.

Hydrocast Data for 1995 Initial Dilution Model. Hydrocast data were collected at approximately monthly intervals during the predesign and pre-discharge phases of the PLOO construction, and as part of the routine monthly monitoring program following commencement of the PLOO discharge in November 1993.

One advantage of the hydrocast data set for use in the 1995 modeling effort was that density profiles were available throughout the year for multiple years. A disadvantage of the hydrocast data set was that the density profiles are subject to aliasing by internal wave and internal tide activity, and by up- and downwelling events. The aliasing effects on the monthly average initial dilutions are reduced if the number of profiles is large. A summary of the number of hydrocast surveys available for each month of the year is presented in Table Q-4.

Table Q-4:
Monthly Hydrocast Data Used in 1995 RSB-TSI Initial Dilution Model

Month	Number of Hydrocast Profiles [A]					
	1990	1991	1992	1993	1994	Total
January	0	0	9	9	9	27
February	4	2	9	9	9	33
March	4	2	9	9	9	33
April	4	2	9	8	9	32
May	3	0	9	9	9	30
June	4	0	9	7	9	29
July	4	9	9	9	9	40
August	4	9	9	9	9	40
September	4	8	9	9	9	39
October	4	9	9	9	9	40
November	0	9	8	1	0	18
December	0	9	4	0	0	13

Table Q-4 Notes:

A. Number of hydrocast data profiles available for the PLOO diffuser area prior to implementation of the extended PLOO.

Water column profiles of temperature and conductivity were collected with a CTD recorder during the hydrocast surveys. Salinity profiles were computed from the water conductivity and temperature. The "equation of state" for sea water[11] was then used with the salinity and temperature profiles to obtain density profiles. For the initial dilution calculations, the density was computed at depth increments of 5 m between the surface and a depth of 95 m. The density information obtained from the hydrocast surveys was used in the RSB-TSI initial dilution model to compute monthly average initial dilutions for the (assumed) case of zero current speed. The lowest value in the set of computed monthly average initial dilutions was selected as representing the "minimum average month initial dilution", as defined by the Ocean Plan.

Time-Series Temperature Data for 1995 Initial Dilution Model. The second type of density stratification information used in the 1995 RBS-TSI modeling effort was collected by using strings of thermistors at four moorings positioned along a cross-shore transect off Point Loma between March and September 1990, and between January and April 1991. These data were collected as part of predesign studies for the PLOO extension and provide the advantage of representing ambient conditions without any possible influence of the PLOO discharge.

The terminus of the PLOO diffuser was constructed close to the location of Mooring T5 (see Figure Q-1, located at the end of this appendix) in 95 m of water. Temperature data during 1990-1991 was collected at half-hour intervals. The string consisted of eleven thermistors, spaced at 5-meter intervals (except for the bottom pair, which had a spacing of 1.5 m). The uppermost thermistor in the string was at a depth of 44.5 m; the lowermost thermistor was at 93.0 m. The time series data set offered the advantage of a short sampling interval which helps to resolve fluctuations in the temperature structure of the water column and minimize aliasing effects.

The initial dilution simulations required information on the density stratification of the water column between the diffuser port and the top of the wastefield. In order to estimate the density structure of the water column above the uppermost thermistor, a time-series of water temperatures was synthesized for this portion of the water column using data obtained from the thermistor strings on the moorings in shallower water. This included measurements at:

- Mooring T4 at depths of 30.5, 35.5, and 40.5 m,
- Mooring T3 at depths of 18.3, 23.3, and 28.3 m, and
- Mooring T2 at 15.5 m.

Surface water temperatures measured at approximately monthly intervals during the hydrocast surveys were interpolated to provide a time-series of estimated surface water temperatures.

The depth to an isotherm surface (surface of constant temperature) can vary over time (ranging from tens of minutes to hours) with the passage of internal tides and internal waves. As these effects propagate through the study area, oscillations can occur among the thermistor moorings in the cross-shore transect. These phase shifts can introduce some anomalies in the synthesized temperature profile at depths shallower than 44.5 m (the uppermost thermistor depth at Mooring T5). On occasion, the shifts were sufficient to produce temperature (and hence density) inversions. In order to reduce the effect of these anomalies, a smoothing function was applied

11 The equation of state for seawater is a diagnostic equation for the density in terms of temperature, salinity and pressure. The international equation of sate for seawater is given by UNESCO (1981).

to the temperature data in order to remove any inversions. For most of the initial dilution simulations, the top of the wastefield was found to lie at, or below, the uppermost thermistor in the Mooring T5 thermistor string. As a result, the upper portion of the water column should be free from any such anomalies induced by phase shifts.

Maximum heights-of-rise are associated with (1) the maximum average annual discharge rate (240 mgd) and (2) the regulatory condition of no ocean currents. For the simulations associated with these worst-case conditions, the top of the wastefield was predicted to rise above a depth of 44.5 m less than 12% of the time.[12] As noted, the RSB-TSI model starts the initial dilution calculation near the discharge port and works its way up the water column. If the predicted height-of-rise is less than 44.5 m, the actual height of rise is guaranteed to be above that depth regardless of any inconsistencies within the synthesized temperature profile of the water column. Large heights-of-rise are often associated with large initial dilutions. Therefore, only the largest predicted initial dilutions would be influenced by inconsistencies in the synthesized temperature profiles.

As input to the 1995 modeling effort, seawater temperatures recorded by the thermistors were converted into water densities using CTD data collected monthly at a set of stations in the vicinity of the mooring and the slowly varying temperature-salinity relationship of the local water mass. Water temperature and conductivity were converted into water salinity, and then water density, as described earlier. Figures Q-2 and Q-3 present plots of water density versus water temperature for the months March and October 1990. A set of first and second order polynomials were used to characterize water density as a function of temperature (indicated by the line segments in Figures Q-2 and Q-3). These analytical relationships were subsequently used within the RSB-TSI initial dilution model to estimate the density structure of the water column from the input measurements of water temperature.

Time-Series Ocean Current Data. Ocean currents belong to the third type of input data. Currents were measured at five stations along the cross-shore transect containing the thermistor moorings (Moorings C1 through C5 on Figure Q-1). Prior to operation of the PLOO, ocean currents were recorded concurrently with water temperature measurements between March and September 1990, and again between January and April 1991 at Mooring C5, located adjacent to the thermistor mooring T5. Currents were measured at depths of 20, 40, 60, and 80 m at half-hour intervals. Initial dilution simulations carried out during the predesign phase indicated that a typical height-of-rise to the level of minimum dilution was on the order of 25 m, corresponding to a wastefield depth of about 68 m. For this height of rise, the entrainment region of the water column during the initial dilution process would be between 68 and 93 m, or an average depth of roughly 80 m. Therefore, the ocean current measurements from a depth of 80 m were used as input for the RSB-TSI initial dilution simulations that evaluated dilution

12 The top of the wastefield was predicted to rise above a depth of 40.5 m in only 2% of the simulations. This 40.5 m depth is the depth of the upper thermistor at Mooring T4, the next closest thermistor mooring to the PLOO diffuser. As a result, the thermistor data provides adequate vertical temperature/density data through the almost the entire range of trapping depths for the PLOO discharge.

under non-zero ocean current conditions.[13]

Confirmation of Applicability of the RSB-TSI Model

As noted earlier, Baumgartner et al. (1993, 1994) endorsed the use of the RSB-TSI model provided that the parameters characterizing the discharge to be simulated are within the range of values examined during the Roberts et al. (1989a,b,c) physical model studies. The primary characteristics of the discharge conditions in the physical model studies are summarized by three dimensionless parameters (Roberts, 1989a). These are:

1. Ratio of the port spacing to a characteristic buoyancy length-scale, L_{SB}.
2. Ratio of a characteristic momentum length-scale to the characteristic buoyancy length-scale, L_{MB}.
3. A Froude number ("Roberts Froude number") involving the speed of the ambient currents past the diffuser, F_R.

The ratio of the port spacing to the buoyancy length-scale, L_{SB}, varied from 0.31 to 1.92. Dilution values are independent of this ratio for values less than 0.3 (Roberts et al., 1989a), where the discharge essentially becomes a line source. Figure Q-4 shows the distribution of L_{SB} values for the simulations for a discharge of 240 mgd and the measured ocean currents. A normal, or Gaussian, distribution of values would lay on a straight line on this probability plot. Only about 1% of the cases simulated have a ratio of less than 0.3 (i.e., the buoyancy length-scale is so large that the discharge acts like a line source). However, all of the cases simulated have ratios less than 1.92, which is the maximum value in the physical model studies. Thus, use of the RSB model for the Point Loma simulations was appropriate from the standpoint of this parameter.

The ratio of the momentum length-scale to the buoyancy length-scale, L_{MB}, is a measure of the relative importance of the energy associated with the jet momentum to the energy associated with the effluent buoyancy. The range of values examined in the physical model studies was from 0.078 to 0.5. Dilution becomes independent of this ratio for values less than 0.1 (Roberts et al., 1989a). The distribution of L_{MB} values for the Point Loma simulations at a discharge rate of 240 mgd is shown on Figure Q-5. The ratios for all the cases were less than 0.35 (smaller discharge rates would result in smaller L_{MB} ratios). About one-half the cases had ratios below 0.1; the dilutions for these cases are equivalent to a discharge with negligible jet momentum.

The Roberts Froude number is related to the ratio of the energy associated with the flow past the diffuser and the energy associated with the buoyancy of the discharge. The values examined in the Roberts et al. (1989a,c) studies ranged from 0.0 to 100. There was no significant effect on the currents for Froude numbers less than 0.1, and the effects were minor for flow parallel to the

13 Mooring C5 at the 80-meter depth failed to record data during an approximate 31-day period between April 19, 1990 to May 21 1990. To address this 31-day data gap, comparisons were carried out to examine the statistical properties (distribution of speeds, net speed, net direction of flow, etc.) of the ocean currents at each depth at Mooring C4 with ocean current data from the 60- and 80-meter depths at Mooring C5. The ocean currents at the 60-meter depth at Mooring C4 were found to most closely correspond to the currents at the 80-meter depth at Mooring C5. Therefore, measurements from 60-meter depth at Mooring C4 were used for the initial dilution calculations for the 31-day period when currents were not recorded at the 80-meter depth at Mooring C5.

diffuser for Froude numbers less than about 1.0. Froude numbers for the PLOO simulations are summarized on Figure Q-6.

Approximately 30% of the values were less than 0.1, hence about one-third of the time there was no significant effect of the currents on the magnitude of the initial dilution. Roughly another one-third of the cases had a Froude number in excess of 1.0. For these cases, the dilution was enhanced by the currents independent of whether the flow was along or perpendicular to the diffuser. The maximum Froude number was 60, which is well within the range of values examined during the physical model studies. These comparisons indicated that the RSB-TSI simulation model was appropriate for the discharge and receiving water conditions existing at the PLOO area.

Validation of 1995 Model Predictions

Simulations were carried out using both the BASIC RSB and RSB-TSI simulation models for ten randomly selected water column stratifications and current conditions. The purpose of this comparison was to validate the predictions generated by the RSB-TSI model. The observations for the comparisons were selected from the time-series data in the following manner:

4. One observation was randomly selected from each group of 130 observations within the total set of 13,757 observations. This produced a set consisting of 100 observations.
5. Ten observations were randomly selected from this group of 100.

In addition, one simulation was carried out for a case where the solution from the RSB-TSI model had a minimum difference between the trial and predicted height-of-rise of 25 cm (versus the "solution found" convergence criteria of 10 cm). The results of the comparison are summarized in Table Q-5.

The initial dilutions and heights-of-rise to the top of the wastefield predicted by the RSB-TSI initial dilution model were comparable to those predicted by the BASIC RSB model. Differences in initial dilution values were less than 1% in 8 of the 10 cases, and heights-of-rise differ by less than 1% in 7 out of the 10 cases. The averages of the initial dilutions predicted by the two RSB models differed by one-tenth of 1%, and the averages of the heights-of-rise were identical. The range of Roberts Froude numbers (F_R) among the 10 cases varied from 0.02 to 15.8 (70% were greater than 0.1, consistent with the distribution of Froude numbers among the 13,757 observations). The angle of the flow relative to the diffuser varied from 6° to 55° (with F_R = 0.44 in the latter case).

Table Q-5:
Comparison of RSB-Basic and RSB-TSI Predictions
Average Annual PLOO Discharge of 240 mgd

Date	No. of Observations	Average Annual Initial Dilution			Height of Rise to Top of Waste Field (meters)		
		RSB-Basic	RSB-TSI	% Difference	RSB-Basic	RSB-TSI	% Difference
03/06/90	107	388:1	392:1	+1.03	35.3	35.9	+1.8
03/28/90	1,165	815:1	811:1	-0.49	36.8	36.8	0.0
04/03/90	1,483	362:1	362:1	0.00	41.2	41.2	+0.1
04/07/90	1,677	387:1	386:1	-0.26	45.6	45.8	+0.5
04/08/90	1,707	275:1	278:1	+1.09	48.8	48.8	-0.1
04/14/90	1,987	554:1	552:1	-0.36	25.9	25.8	-0.3
09/22/90	9,741	431:1	431:1	0.00	39.9	40.0	+0.3
01/19/91	10,299	224:1	223:1	-0.45	27.8	27.3	-1.7
02/08/91	11,246	197:1	196:1	-0.51	29.2	28.7	-1.7
03/06/91	12,501	483:1	481:1	-0.41	39.0	39.1	+0.2
Average		**411.6:1**	**411.2:1**	**-0.10**	**36.95**	**36.95**	**0.0**

Although the test cases in Table Q-5 represent a random selection from among the 13,757 observations in the time-series, they do not include representatives from each of the seasons spanned by the data. Therefore, a second stratified random sampling was carried out. In this sampling, the time-series was partitioned into ten sequential groups, each consisting of 1,375 observations (28.65 days). An observation was then randomly selected from each of the groups. The results are summarized in Table Q-6.

As might be expected, the results were comparable to the previous comparison. Differences between the predicted flux-averaged dilutions and also the height-of-rise to the top of the wastefield were less than 1% in 9 out of the 10 cases. The average difference between the two predicted initial dilutions was 0.15%; and the average difference between the heights-of-rise was 0.34% (in both cases the RSB-TSI predictions were lower).

Table Q-6:
Comparison of RSB-Basic and RSB-TSI Predictions
Average Annual PLOO Discharge of 205 mgd

Date	No. of Observations	Average Annual Initial Dilution			Height of Rise to Top of Waste Field (meters)		
		RSB-Basic	RSB-TSI	% Difference	RSB-Basic	RSB-TSI	% Difference
03/28/90	1,164	942:1	944:1	+0.21	41.4	41.4	-0.0
04/03/90	1,463	412:1	411:1	-0.24	40.8	40.8	+0.0
05/10/90	3,221	353:1	352:1	-0.28	35.6	35.6	+0.0
06/16/90	5,012	229:1	229:1	-0.00	30.0	30.1	+0.4
06/30/90	5,670	362:1	364:1	+0.55	36.6	36.6	+0.1
07/25/90	6,903	490:1	492:1	+0.41	42.8	42.7	-0.2
09/04/90	8,858	371:1	364:1	-1.91	51.1	50.6	-0.9
01/29/91	10,784	337:1	335:1	-0.60	32.3	31.7	-1.8
02/09/91	11,311	279:1	279:1	-0.00	37.4	37.1	-0.8
03/05/91	12,480	291:1	290:1	-0.34	35.9	36.0	+0.2
Average		**406.6:1**	**406.0:1**	**-0.15**	**38.39**	**38.26**	**-0.34**

These results demonstrated that the predictions from the RSB-TSI model were comparable to those generated by the BASIC-RSB model, and that the RSB-TSI model is capable of providing adequate predictions for cases where the BASIC-RSB model fails.

Q.4 RESULTS FROM 1995 RSB-TSI INITIAL DILUTION MODEL

To statistically characterize the range of initial dilutions that are achieved by the PLOO, initial dilutions were computed using time-series of simultaneously measured water column temperatures and ocean currents. Measurements prior to the operation of the extended PLOO were available for the period from March 3 (Calendar Day 63, or CD063) to September 29, 1990 (CD270), and from January 11 (CD011) to April 1, 1991 (CD091). Initial dilutions were calculated at one-half hour intervals for a total of 13,757 individual cases.

240 mgd Maximum Annual Average Design Flow

The time-series of flux-averaged initial dilution values for the measurements in 1990 is illustrated by the bold line on Figure Q-7, and the time-series for 1991 is illustrated by the light line. As shown in the figures, large variations in the magnitude of initial dilution can occur within a tidal cycle, and these fluctuations are superimposed on variations occurring over longer time-scales. As also shown in the figures, initial dilutions between CD063 and CO091 in 1991 were generally lower than during the same period in 1990.

The probability distribution of initial dilution magnitudes for all the observations (e.g., with currents) is illustrated by the solid line on Figure Q-8. The dashed line indicates the distribution for the initial dilutions computed with the regulatory requirement of no ambient current.

Resulting flux-averaged initial dilutions corresponding to selected probability levels are summarized in Table Q-7.

The effect of ocean currents on initial dilution was greatest at the highest dilutions (low initial dilutions tend to be associated with weak currents). The minimum simulated instantaneous flux-averaged initial dilutions with and without currents were nearly equal at 126:1 and 123:1. The presence of currents increased the median (50th percentile) value from 283:1 to 338:1 (an increase of almost 20%); the maximum initial dilution is increased by nearly 300%.

Table Q-7:
Distribution of Flux-Averaged Initial Dilutions
Average Annual PLOO Discharge of 240 mgd

Probability	Computed Flux-Averaged Initial Dilution [A]	
	With Currents	Without Currents
5th Percentile	200:1	183:1
10th Percentile	223:1	202:1
30th Percentile	284:1	248:1
50th Percentile	338:1	283:1
70th Percentile	409:1	319:1
90th Percentile	544:1	389:1
95th Percentile	634:1	431:1

Table Q-7 Notes:

A. Probability profile for simulated flux-averaged initial dilution for an annual PLOO discharge flow of 240 mgd. The 5th percentile value is equaled or exceeded 95% of the time.

A running 30-day average of the initial dilutions is shown on Figure Q-9. The solid line represents the 30-day average initial dilutions calculated with the actual currents; the dashed line, the 30-day average initial dilutions calculated by setting the currents equal to zero. Each 30-day period begins on the calendar day shown at the bottom of the plot. For example, the 30-day average for the month of April begins on CD091. In the absence of currents, the lowest 30-day average (regulatory) initial dilutions occurred between January 15-25, with values falling to as low as 221:1. Two secondary minima occurred around late April (approximately CD117) and early August (CD217), with values of 246:1 and 293:1, respectively. The maximum 30-day average initial dilution was 360:1 (CD239, August 25).

205 mgd Maximum Annual Average Projected Flow

The time-series of flux-averaged initial dilution values for the measurements in 1990 is illustrated by the bold line on Figure Q-10, and the time-series for 1991 by the light line. The probability distribution of initial dilution magnitudes for all the observations (e.g., with currents) is illustrated by the solid line on Figure Q-11. The dashed line indicates the distribution for the initial dilutions computed with no ambient current. Table Q-8 presents a statistical profile of the simulated initial dilution values. As shown in Table Q-8, the presence of currents increased the median (50th percentile) value from 300:1 to 365:1 (an increase of about 22%). The maximum initial dilution was increased by 280%.

Table Q-8:
Distribution of Flux-Averaged Initial Dilutions
Average Annual PLOO Discharge of 205 mgd

Probability	Computed Flux-Averaged Initial Dilution [A]	
	With Currents	Without Currents
5th Percentile	215	194
10th Percentile	239	214
30th Percentile	306	262
50th Percentile	365	300
70th Percentile	443	340
90th Percentile	592	409
95th Percentile	686	455

Table Q-8 Notes:
A. Probability profile for simulated flux-averaged initial dilution for a PLOO discharge flow of 205 mgd. The 5th percentile value is equaled or exceeded 95% of the time.

A running 30-day average of the initial dilutions simulated by the 1995 RSB-TSI model is presented in Figure Q-12. The solid line represents the 30-day average initial dilutions calculated with the actual currents; the dashed line, the 30-day average initial dilutions calculated by setting the currents equal to zero. The lowest 30-day average (regulatory) initial dilutions in the absence of currents occurred on about January 15-16 (CD15-16), with a value of 221:1. Similarly, two secondary minima occurred around late April (CD114) and early August (CD217), with values of 245:1 and 292:1, respectively. The maximum 30-day average initial dilution was 481:1 (CD239, August 25).

Comparison of Initial Dilutions for 205 mgd and 240 mgd.

Figure Q-13 compares the initial dilution probability distributions for PLOO discharge flows of 205 and 240 mgd. As shown in Figure Q-13, the initial dilutions associated with the 205 mgd discharge (solid line) were about 7% higher than those associated with a discharge of 240 mgd (dashed line). This was slightly higher than the 5% increase expected for a buoyant plume from a line source in receiving waters with a constant density gradient, but was in agreement with expectations for a buoyancy-dominated discharge. It should be noted, however, that dilutions for some individual observations may be greater for a discharge of 240 mgd than for 205 mgd, depending on stratification conditions within the water column.

Diurnal Variations in the Initial Dilution.

The magnitude of the initial dilution depends on the density stratification of the receiving water, the strength and direction of the ocean currents, and the discharge rate. Surface and internal tides of semidiurnal and diurnal frequency change the density stratification of the water column and the ocean currents over the course of a day. Similarly, the volumetric discharge has a diurnal cycle. The magnitude of the initial dilution will normally be affected by phasing of these fluctuations relative to one another, and may be either enhanced or diminished.

Figures Q-14 and Q-15 demonstrate the interplay between (1) the semidiurnal and diurnal tidal period changes in the currents and in the water column stratification, and (2) the diurnal changes in PLOO discharge flows. The figures present the predicted initial dilutions for the period from CD035 to CD040 (February 4 to 9) in 1991 for various discharge and receiving water conditions. Figure Q-14 illustrates the dilutions in the presence of the measured currents and Figure Q-15 without currents. The solid line represents the most realistic estimate, since it includes the variations in the stratification of the water column, currents, and discharge rate. A semidiurnal (two cycles per day) fluctuation was evident in the magnitude of the initial dilution. However, the two peaks within a day were often of different magnitudes, which may be reflective of diurnal fluctuations in the receiving waters and/or the discharge rate.

The effect of the varying discharge rate is evident by comparing the initial dilutions predicted for a constant discharge rate (dashed line) with those with the sequence of initial dilutions with the varying discharge rate. At times, the magnitude of the initial dilution may be either enhanced or diminished, depending on the phase of the receiving water and discharge rate fluctuations. In some cases, the difference is as much as 60% to 70% during this period.

Figure Q-15 presents simulated initial dilutions for the same set of conditions, but with ocean currents set equal to zero. The dashed line in Figure Q-15 illustrates the variations in the initial dilution that result solely from changes in the density stratification of the water column. As shown in Figure Q-15, semidiurnal period density fluctuations were sufficient to change initial dilutions by as much as 80% over the course of one-half a period (6 hours).

Comparison of the initial dilutions for a constant discharge rate (dashed lines - Figures Q-14 and Q-15) illustrates the importance of the tidal period current fluctuations. During this time period, the difference between the highs and the lows is greater in the presence of the currents than in their absence. This suggested that the semidiurnal tidal period variations in the density stratification and in the currents were phased to enhance the variations in the initial dilution.

These variations indicate that care must be exercised in computing regulatory minimum month average initial dilutions based on hydrocast data. Since each station is only sampled once during each hydrocast survey, the sample represents only one of the possible stratifications of the water column that may exist over the course of a diurnal tidal cycle. Therefore, the initial dilution predictions may be biased by the tidal fluctuations unless a sufficient number of density profiles are collected so that the set is representative of the range of stratifications existing during each monthly period.

Ocean Plan Initial Dilutions

As noted, the Ocean Plan requires that the initial dilutions be determined on the basis of zero ocean currents. As part of the 1995 modeling effort, Ocean Plan-based initial dilutions were simulated by assigning zero ocean current and performing modeling simulations using both the CTD data and the time-series data.

The CTD casts were divided into twelve sets, each corresponding to one month of the year. The years for which CTD data was available is summarized in Table Q-9. More than one profile was available for each month of each year. However, these data corresponded to profiles collected on the same day, or separated by two days, at multiple hydrocast stations near the outfall. For example, the nine profiles available for the month of January 1992 were all collected on the same day. The purpose of using data from more than one hydrocast station was to average out the effects of the density variations associated with internal waves and tides (the data were collected over a period of several hours).

240 mgd - Maximum Annual Average Design Flow

The regulatory initial dilutions for a discharge of 240 mgd are summarized by month in Table Q-9 (below). The regulatory average initial dilution is the average of all the values during the month. Computed initial dilution values ranged from lows of 202 to 206:1 in the winter (January, December), to highs of 320 to 324:1 in early summer (June, July). The value of 202:1 corresponds to the regulatory minimum month average initial dilution addressed within the Ocean Plan.

Table Q-9:
30-Day Average Initial Dilution Hydrocast Data - No Currents
Average Annual PLOO Discharge of 240 mgd

Month	Average Initial Dilution [A]
January	202:1
February	224:1
March	263:1
April	284:1
May	295:1
June	324:1
July	320:1
August	294:1
September	307:1
October	281:1
November	249:1
December	206:1

Table Q-9 Notes:

A. Monthly average initial dilutions computed using hydrocast data and no currents for a maximum PLOO Discharge flow of 240 mgd.

Ocean Plan-based monthly average initial dilutions were also estimated using the 30-day running average initial dilutions computed from the time-series measurements for no currents. The monthly average corresponds to the 30-day running average beginning on the calendar day corresponding to the first day of each month (for example, the February monthly average would correspond to calendar day 032). The resulting regulatory monthly average initial dilutions for the time-series from 1990 and 1991 are summarized in Table Q-10.

The regulatory monthly average initial dilutions predicted from the time-series ranged from lows of 227:1 in the winter (January, February) to a high of 359:1 in early fall (September). The value of 227:1 corresponded to the regulatory minimum monthly average initial dilution based on the time-series data. This value was about 12% higher than the regulatory minimum monthly average initial dilution based on the CTD data.

Table Q-10:
30-Day Average Initial Dilution, Time-Series Data, No Currents, Average Annual PLOO Discharge of 240 mgd

Month	Computed 30-Day Average Initial Dilution		
	Based on Time Series Data from 1990 [A]	Based on Time Series Data from 1991 [A]	Based on CTD Data 1990-1994 [B]
January	No Data	227:1 [C]	202:1
February	No Data	227:1	224:1
March	317:1 [D]	267:1	263:1
April	285:1	No Data	284:1
May	260:1	No Data	295:1
June	304:1	No Data	324:1
July	341:1	No Data	320:1
August	294:1	No Data	294:1
September	359:1 [E]	No Data	307:1
October	No Data	No Data	281:1
November	No Data	No Data	249:1
December	No Data	No Data	206:1

Table Q-10 Notes:

A. Computed 30-day average initial dilutions based on a 240 mgd discharge flow and oceanographic time series data from 1990 and 1991 collected prior to construction of the PLOO.

B. Based on ocean density data from 1990-1994 collected prior to operation of the extended PLOO.

C. Value for calendar day 11.

D. Value for calendar day 63.

E. Value for calendar day 239.

Overall, the 1995 modeling effort concluded that the regulatory 30-day average initial dilutions predicted from the time-series data were similar to the values predicted using the CTD data. This indicates that the initial dilution projections are primarily influenced by the relatively predictable seasonal trends in water column density, and less by internal wave aliasing or interannual variability.[14]

The average of all the regulatory monthly initial dilutions for the 240 mgd discharge flow based on the time-series data was 288:1. This is about 4% greater than the regulatory monthly average initial dilution of 276:1 predicted from the CTD data. The variability of the regulatory monthly average initial dilutions within the year is illustrated on Figure Q-16. Initial dilutions predicted from the time-series data ranged from a low of 227:1 (January-February) to a high of 359:1

14 Note that the time-series measurements were made in 1990 and early 1991, while the hydrocast data were weighted towards measurements from the years 1992 to 1994.

(September), compared with the range of 202:1 to 324:1 predicted from the hydrocast data. The average of all the time-series based initial dilutions was 287:1, or about 3% greater than the average of 279:1 for all the hydrocast-based initial dilutions during the same months.

205 mgd - Maximum Annual Average Flow

Table Q-11 presents minimum monthly initial dilutions computed using the hydrocast CTD data from 1990-1991 (prior to construction of the PLOO extension). As shown below in Table Q-11, the minimum initial dilution for a PLOO discharge of 205 mgd ranged from 204:1 (February conditions) to 354:1 (June conditions).

Table Q-11:
30-Day Average Initial Dilution
Hydrocast Data - No Currents
Average Annual PLOO Discharge of 205 mgd

Month	Average Initial Dilution [A]
January	214:1
February	204:1
March	264:1
April	313:1
May	315:1
June	354:1
July	325:1
August	325:1
September	317:1
October	287:1
November	264:1
December	217:1

Table Q-11 Notes:

A. Monthly average initial dilutions computed using hydrocast data and no currents for a PLOO discharge flow of 205 mgd.

The 30-day average regulatory initial dilutions for the time-series in 1990 and 1991 are summarized in Table Q-12. The winter lows in the regulatory monthly average initial dilutions predicted from the time-series data ranged from 238:1 to 241:1 (January-February); the early autumn highs reach 384:1 (September). This compares favorably with the range of 204:1 to 354:1 predicted from the hydrocast data. The average of all the time-series based regulatory monthly average initial dilutions was 305:1. This 305:1 value is approximately 4% greater than the average of 292:1 based on the hydrocast data for the same months. The distribution of regulatory monthly average initial dilutions within the year is illustrated in Figure Q-17.

**Table Q-12:
30-Day Average Initial Dilution
Time-Series Data, No Currents
Average Annual PLOO Discharge of 205 mgd**

Month	Beginning Calendar Day of the Month	Computed 30-Day Average Initial Dilution		
		Based on Time Series Data from 1990 [A]	Based on Time Series Data from 1991 [A]	Based on CTD Data 1990-1994 [B]
January	1	No Data	238:1 [C]	214:1
February	32	No Data	241:1	204:1
March	60	337:1 [D]	287:1	264:1
April	91	300:1	No Data	313:1
May	121	275:1	No Data	315:1
June	152	324:1	No Data	354:1
July	182	359:1	No Data	325:1
August	213	310:1	No Data	325:1
September	244	384:1 [E]	No Data	317:1
October	274	No Data	No Data	287:1
November	305	No Data	No Data	264:1
December	335	No Data	No Data	217:1

Table Q-12 Notes:

A. Computed 30-day average initial dilutions based on a 205 mgd discharge flow and time series oceanographic data from 1990 and 1991 collected prior to construction of the PLOO.

B. Based on ocean density data from 1990-1994 collected prior to operation of the extended PLOO.

C. Value for calendar day 11.

D. Value for calendar day 63.

E. Value for calendar day 239.

Based on the time-series data used in the 1995 model, the regulatory minimum monthly average initial dilution required for assessing compliance with Ocean Plan Table 3 receiving water quality objectives was 238:1. The corresponding regulatory minimum month average initial dilution computed using the hydrocast data was 204:1.[15]

15 As discussed on page F-7 of Appendix F to Order No. R9-2017-0007, EPA and the RWQCB elected to assign a 204:1 initial dilution to the PLOO on the basis of a 205 mgd PLOO discharge flow and the initial dilution simulations shown above using the hydrocast data. This 204:1 initial dilution is used within Order No. R9-2017-0007 (and prior NPDES permit for the extended PLOO) for establishing water quality-based effluent limits and performance goals.

Height of Rise

The height-of-rise to the level of minimum dilution, bottom of the wastefield, and top of the wastefield varies over the same time-scales characterizing the variations in the magnitudes of the initial dilutions (e.g., hours to years). The monthly average wastefield depths for an annual average flow of 205 mgd, based on the time-series data from 1990 and 1991, are illustrated in Figures Q-18. Also shown is the projected maximum height-of-rise to the top of the wastefield during each month.

For annual average flows of 205 mgd and 240 mgd, the height-of-rise to the level of minimum dilution varied from about 20 to 31 m, corresponding to depths of 62 to 74 m below the surface.[16] In general, the months with the highest heights-of-rise also tended to have the highest initial dilutions. The average height-of-rise to the top of the wastefield at the completion of the initial dilution process varied from about 30 to 40 m, corresponding to depths of about 54 to 64 m below the surface. The maximum height-of-rise to the top of the wastefield varied from about 50 to 64 m, corresponding to depths of about 30 to 44 m. For comparison, the water depth at the outer edge of the kelp bed lying inshore from the PLOO is about 16 to 17 m; the water depth at the outer edge of the San Diego bight (i.e., along an extension of the Point Loma coastline) lying downcoast, is about 40-45 m.

Q.5 BASIS OF INITIAL DILUTION ASSIGNED IN ORDER NO. R9-2017-0007

Within Order No. R9-2017-0007 (NPDES CA0107409), EPA and the RWQCB establishes effluent requirements for the PLOO discharge using an assigned minimum monthly average initial dilution of 204:1 (e.g., 204 parts seawater per part wastewater), which is the lowest monthly average initial dilution value determined within the 1995 modeling effort using the RSB-TSI model and supplemental dilution modeling conducted using the EPA modeling application Visual Plumes (UM3).[17]

Subsequent Initial Dilution Modeling

As documented within Attachment H of Order No. R9-2017-0007, subsequent initial dilution modeling using the UM3 model was conducted both by the City of San Diego and by EPA/RWQCB. A PLOO discharge flow of 205 mgd was utilized in the UM3 model (see Section B.9 of Attachment H to Order No. R9-2017-0007) on the basis of the following:

> *The 301(h)-variance-based flow for the Discharger is 205 MGD. The Discharger currently discharges a monthly average flow significantly below this value which would result in a greater (and less conservative) dilution value. Because the Discharger will continue to be capable of*

16 The mean height of rise for a 205 mgd flow, for example, was 26.6 m.

17 The Visual Plumes model is a Windows-based computer application that superseded the DOS-based PLUMES model developed by Baumgartner, Frick and Roberts (1995).

> *discharging up to 205 MGD, and this is the most conservative value to use while calculating dilution, 205 MGD was considered to be the applicable discharge volume through the outfall.*[18]

As reported in Appendix H of Order No. R9-2017-0007, the City utilized the UM3 model in 2008 to assess initial dilution using temperature/salinity/density data during 2003-2007 from Monitoring Locations F29, F30 and F31. Ocean density profiles during January were determined to represent minimum month conditions for the PLOO. Table Q-13 summarizes results from this supplemental modeling using the UM3 model. Based on these modeling results, January 2007 was determined to represent minimum month conditions. The projected PLOO minimum month initial dilution during January 2007 was projected at 225.5:1, a value approximately 10% greater than the 204:1 value simulated in the City's 1995 RSB-TSI initial dilution model.

Table Q-13:
Projected Monthly Average Initial Dilution During Critical Month (January)
Average Annual PLOO Discharge of 205 mgd

Month	Monthly Average Initial Dilution [A]
January 2003	228.3 : 1
January 2004	249.8 : 1
January 2005	244.1 : 1
January 2006	241.1 : 1
January 2007	225.5 : 1

Table Q-13 Notes:

A. Monthly average initial dilutions computed by the City of San Diego in 2008 (report dated October 27, 2008) using the EPA model UM3, as reported within Appendix H of Order No. R9-2017-0007. Results were based on a PLOO discharge flow of 240 mgd and worst-case temperature/density profile data from Stations F29, F30 and F31 for January, which was determined to be the most critical month.

Using data from 2003-2007, EPA and the RWQCB conducted additional modeling of the PLOO discharge using the UM3 model. As reported within Appendix H of Order No. R9-2017-0007, this supplemental EPA/RWQCB modeling projected initial dilution values in excess of those simulated in both the City's 1995 RSB-TSI modeling effort or the 2008 effort that used the UM3 model. Using the most critical monthly temperature/density profile of January 2007, the EPA/RWQCB modeling effort projected a minimum month initial dilution of 227.2:1, a value essentially identical to the 225.5:1 dilution computed by the City using the UM3 model.

Rationale for Use of 204:1 Minimum Month Initial Dilution

In establishing requirements of Order No. R9-2017-0007 (NPDES CA0107409), EPA and the RWQCB elected to carry over the 204:1 initial dilution value from prior PLOO NPDES permits. As rationale for carrying over this 204:1 initial dilution value, the Fact Sheet of Order No. R9-2017-0007 states:

18 See Item No. 9, page H-3, Appendix H of Order No. R9-2017-0007.

Order No. R9-2009-0001 carried over an initial dilution value for the PLOO of 204 parts seawater per part wastewater (204:1) from previous orders for the Facility. This initial dilution value was established based on the results of a modified version of the RSB model, submitted with the Discharger's 1995 ROWD and the Discharger's 1995, 2001, 2007, and 2015 301(h) applications to USEPA, Region IX. This initial dilution value was predicated based on the 301(h)-variance-based effluent flow of 205 MGD from the Facility. For the 2015 ROWD, the Facility end-of-permit term (calendar year 2022) projected average annual flow is 171 MGD. Because the Facility end-of-permit projected flow of 171 MGD is less than the 301(h)-variance-based flow of 205 MGD evaluated by USEPA, Region IX in the 1995, 2001, and 2007 applications, USEPA, Region IX believes that the 301(h)- variance-based flow of 205 MGD continues to be a reasonable estimate for evaluating initial dilutions in the 2015 application. Thus, this Order/Permit carries over the initial dilution value of 204:1, as discussed in Attachment H. This 301(h)-variance-based flow of 205 MGD and minimum initial dilution value of 204:1 is used by the San Diego Water Board and USEPA, Region IX to establish water quality-based effluent limitations (WQBELs) and performance goals and calculate mass-based effluent limitations for this Order/Permit, as discussed in section IV.B and C of this Fact Sheet.[19]

Q.6 CONSISTENCY OF MONITORING DATA WITH DILUTION MODELS RESULTS

The comprehensive PLOO ocean monitoring program required under Order No. R9-2017-0007 includes monitoring of ocean water quality using a range of methods and instrumentation, including:

- Conductivity, temperature, depth (CTD)
- Acoustic Doppler Current Profilers (ADCPs),
- Real-Time Oceanographic Mooring Systems, and
- Remotely Operated Towed Vehicles (ROTVs).

Additionally, water quality samples are regularly collected throughout the PLOO monitoring field for fecal indicator bacteria parameters such as enterococcus. While a number of limitations exist that prevent the PLOO monitoring data from being used to accurately determine PLOO dilutions, data collected as part of the PLOO ocean monitoring program can be used to demonstrate consistency with the average monthly PLOO initial dilution of 204:1 (under minimum month conditions) that is assigned within Order No. R9-2017-0007.

Consistency of Plume Tracking Results with Dilution Modeling.

As documented within Appendix D (2017-2020 Point Loma Plume Tracking Study), a number of parameters are useful for tracking the PLOO discharge, including temperature, conductivity (used to calculate salinity), dissolved oxygen, pH, transmissivity (i.e., water clarity), chlorophyll *a* fluorescence (a proxy for phytoplankton), and colored dissolved organic matter (CDOM) fluorescence.

19 See Section II.C (page F-7) of Appendix F of Order No. R9-2017-0007 (NPDES CA0107409).

Rogowski et al. (2012) used this multi-parameter approach in combination with instrumentation mounted on an autonomous underwater vehicle (AUV) for evaluating PLOO plume movement and assessing outfall performance.[20] As part of this effort, Rogowski et al. (2012) estimated dilutions at various locations along the AUV track by comparing CDOM samples of the PLOO effluent with receiving water CDOM measurements. Table Q-14 summarizes minimum dilutions reported by Rogowski et al. (2012).

Minimum estimated dilutions reported by Rogowski et al. (2012) during the AUV transits of the PLOO plume ranged from 103:1 to more than 300:1 (Table Q-14). The average of the minimum estimated dilutions reported by Rogowski et al. during the 2010-11 AUV missions was 170:1.

It should be noted that the minimum estimated dilutions reported by Rogowski et al. (2012) are from CDOM measurements at specific locations and are not necessarily representative of flux-averaged or depth-averaged initial dilutions throughout the water column or PLOO discharge plume. Additionally:

- Minimum estimated dilutions estimated by Rogowski et al. occurred at different locations during each date and AUV deployment. As a result, minimum estimated dilutions shown in Table Q-15 are not reflective of longer-term dilutions at any given location.
- Initial dilution may not have yet been completed at the time and location of all CDOM readings collected by Rogowski et al. As a result, some of the reported minimum estimated dilutions are lower than values that would be achieved once initial dilution is completed.
- Dilution estimates reported by Rogowski et al. are based on the assumptions that (1) the CDOM signature of the PLOO discharge remains constant, and (2) no spatial variation occurs in naturally-occurring CDOM. A number of natural phenomena exist (such as the Point Loma kelp bed, upwelling events, or sediment resuspension), which may cause localized variability in naturally-occurring CDOM.[21] Any localized phenomena that result in increased ambient CDOM concentrations would result in an underestimation of the minimum estimated dilution.

20 The Rogowski et al. (2012) study was presented as Appendix F within the City's 2015 application package for renewal of 301(h) modified secondary treatment requirements for the PLOO discharge.

21 It is possible that contributions of CDOM from natural sources (e.g., Point Loma kelp bed) are higher in the vicinity of the PLOO than in upcoast and downcoast reference stations. Additionally, ambient receiving water CDOM can be locally affected by upwelling events, ocean currents, sediment resuspension, or shore-based sources. Any such localized increase in naturally-occurring CDOM would downwardly skew estimated CDOM-based PLOO dilution values.

**Table Q-14:
Estimated Instantaneous Dilution Values
Based on Observed Concentrations of Colored Dissolved Organic Matter, 2010-11 [A]**

AUV Deployment Date	Minimum Observed PLOO Plume Depth (meters)	Minimum Estimated Dilution [B]
2010/04/15	37	141:1
2010/05/19	44	188:1
2010/06/16	52	177:1
2010/06/25	56	110:1
2010/07/14	40	125:1
2010/08/03	45	127:1
2010/09/01	47	193:1
2010/10/14	57	192:1
2010/10/28	57	184:1
2010/11/16	51	117:1
2010/11/30	50	304:1
2010/12/08	50	161:1
2010/12/16	60	248:1
2011/01/21	67	160:1
2011/01/28	64	162:1
2011/02/25	58	228:1
2011/02/28	35	103:1
2011/03/03	45	109:1
2011/04/15	57	204:1
2011/04/22	50	157:1
Average Minimum Dilution [C]	---	170:1
Median Minimum Dilution [D]	---	162:1

Table Q-14 Notes:

A. As reported by Rogowski et al. (2012)

B. Minimum dilution estimate based on comparing measured receiving water CDOM concentrations with a previously collected PLOO CDOM sample. Estimated minimum dilutions are based on the assumption that ambient CDOM concentrations are homogeneous and that PLOO CDOM concentrations remain constant.

C. Arithmetic average of minimum estimated dilution values reported for the above AUV deployment dates.

D. Median value of minimum estimated dilution values reported for the above AUV deployment dates.

Even so, the minimum dilutions reported by Rogowski et al. (2012) are close to the simulated minimum flux-average dilutions predicted by the 1995 RSB-TSI model (see Figure Q-11). Further, since the Ocean Plan-based initial dilution of 204:1 represents a value that is averaged over the discharge plume during a month (under minimum month conditions), it would be expected that most (or nearly all) minimum observed CDOM-based dilution estimates would be less than this 204:1 minimum monthly average value.

While the CDOM-derived minimum initial dilutions appear to be consistent with past model results, it is important to emphasize the difference between the CDOM-based minimum dilution values and minimum month initial dilution as defined within the Ocean Plan. Given the limitations and uncertainties associated with CDOM-derived dilution estimates, the current methodology set forth in the Ocean Plan (e.g., use of initial dilution models) represents the most reliable and appropriate means for determining average monthly initial dilution during minimum month conditions.

As a final note, minimum estimated PLOO dilutions reported by Rogowski et al. (2012) are consistent with ensuring compliance with applicable Ocean Plan receiving water quality objectives and ensuring protection of beneficial uses. While effluent limitations within Order No. R9-2017-0007 are established on the basis of a minimum month initial dilution of 204:1, the PLOO discharge has historically complied with effluent limitations by a significant margin. As a result, at specific locations and instantaneous time periods where and when the PLOO effluent is diluted by less than 204:1, receiving waters in the vicinity of the PLOO will continue to comply with Ocean Plan receiving water quality objectives.

Additionally, the most stringent Ocean Plan concentration objectives are based on preventing potential chronic impacts associated with long-term exposure of habitat or species to low levels of contaminants.[22] Using the average initial dilution during minimum month conditions to establish NPDES permit effluent limits represents a conservative approach for preventing such chronic impacts, as average initial dilution at any given location over long periods of exposure would be higher than the average monthly value during minimum month conditions.

Consistency of Enterococcus Data with Dilution Model Results.

Concentrations of enterococcus are regularly monitored in the PLWTP effluent and at all PLOO shoreline, kelp bed and offshore monitoring stations. Comparison of effluent and receiving water enterococcus concentrations can be used to assess overall outfall performance. As documented within Appendix H (Beneficial Use Assessment), median concentrations of enterococcus in the PLWTP effluent during 2017-2020 were on the order of 2.6×10^4 organisms per 100 milliliters (mL); 90% of the PLWTP effluent samples contained enterococcus concentrations in excess of 6.4×10^3 per 100 mL.

Kelp Bed Monitoring. Of the more than 5000 receiving water surface, mid-depth and bottom samples collected at kelp bed monitoring stations during 2017-2020, only four samples exceeded an enterococcus concentration of 1×10^2 per 100 mL. Enterococcus concentrations in almost all other kelp bed and nearshore samples during 2017-2020 were less than 10 per 100 mL.

Monitoring at Offshore Stations. As documented within Appendix D, ocean currents typically carry the PLOO discharge upcoast or downcoast parallel to isobath contours. Ocean Monitoring

22 The most stringent Ocean Plan receiving water quality objectives are (1) 6-month median objectives for the protection of aquatic habitat which prevent chromic effects associated with long-term exposure, and (2) 30-day average objectives for the protection of human health from consumption of organisms. See Table 3 of the Ocean Plan.

stations F31 and F29 are respectively immediately north and south of the PLOO diffuser, and are the monitoring stations most likely to be representative of ocean water quality upon completion of initial dilution within the PLOO zone of initial dilution (ZID).

Table Q-15 summarizes enterococcus concentrations at Stations F31 and F29 during 2017-2020. As shown in the table, median enterococcus concentrations at F31 during 2017-2020 were below 6 per 100 mL at all depths. At F29, median enterococcus concentrations were less than 7 per 100 at all depths except the 80-meter depth, where the median value was 44 per 100 mL. Receiving water results at Stations F31 and F29 during 2017-2020 demonstrate a significant reduction in enterococcus concentrations (well in excess of two orders of magnitude) compared to those in the PLWTP effluent. These enterococcus monitoring results are consistent with PLOO initial dilution projections developed in the 1995 RSB-TSI model and in subsequent simulations conducted by the City and EPA/RWQCB using the UM3 model.

Q.7 PROPOSED RETENTION OF ASSIGNED 204:1 PLOO INITIAL DILUTION

The findings presented in Section Q.6 demonstrate that the 204:1 minimum month PLOO initial dilution assigned in prior NPDES permits remains valid and represents a conservative approach for protecting ocean water quality and beneficial uses. In addition to being confirmed through various validated initial dilution models, this 204:1 minimum monthly average initial dilution value is consistent with dilution estimates developed using AUVs and ROTVs to monitor CDOM concentrations in the PLOO ZID and beyond.

To ensure conformance with antidegradation and anti-backsliding requirements, the City proposes continuation of EPA/RWQCB approach employed within Order No. R9-2017-0007 of:

- utilizing a 205 mgd flow as the basis for assessing PLOO initial dilution, and
- retaining the 204:1 initial dilution value that has been assigned as part of each of the prior PLOO 301(h) discharge permits.

Table Q-15:
Receiving Water Enterococcus Concentrations During 2017-2020 at Stations F31 and F29 Located Immediately Upcoast and Downcoast from the PLOO Diffuser

Depth (meters)	Receiving Water Enterococcus Concentration (number per 100 mL) [A]			
	Station F29 [B] Downcoast from the PLOO Diffuser		Station F31 [C] Upcoast of the PLOO Diffuser	
	75th Percentile Value	Median Value	75th Percentile Value	Median Value
1	2	2	2	2
25	2	2	2	2
60	2	2	2	2
80	43	5	123	44
98	21	6	30	7

Table Q-15 Notes:

A. Based on receiving water enterococcus monitoring data from January 2017 through December 2020, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. See Appendix H for the location of Stations F31 and F29. For reference, median PLWTP effluent concentrations of enterococcus during 2017-2020 were approximately 2.6 x 104 per 100 mL.

B. Station F29 is the closest monitoring station immediately upcoast from the PLOO diffuser, and is located along the 98-meter depth contour approximately 1000 m north of the north end of the PLOO diffuser.

C. Station F31 is the closest monitoring station immediately downcoast from the PLOO diffuser, and is located along the 98-meter depth contour approximately 1000 m south of the south end of the PLOO diffuser.

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United States Environmental Protection Agency and Regional Water Quality Control Board (RWQCB), 2017. Order No. R9-2017-0007, (NPDES CA0107409), Waste Discharge Requirements and National Pollutant Discharge Elimination System (NPDES) Permit for the City of San Diego E.W. Blom Point Loma Wastewater Treatment Plant Discharge to the Pacific Ocean through the Point Loma Ocean Outfall.

Figure Q-1:
Study Area Monitoring Stations to Support 1995 RSB-TSI Model

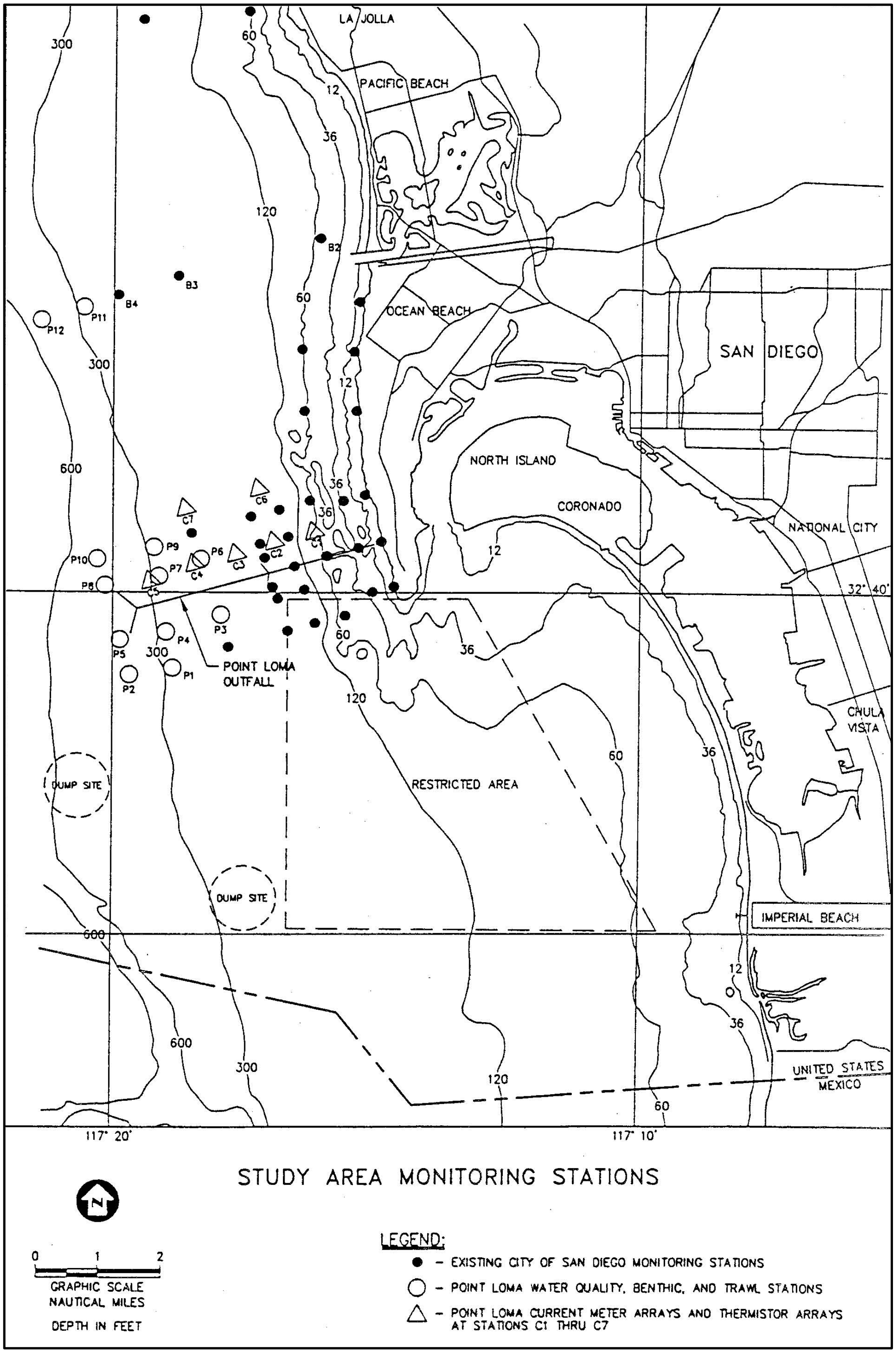


Figure Q-2:
Water Temperature vs. Density, March 1990

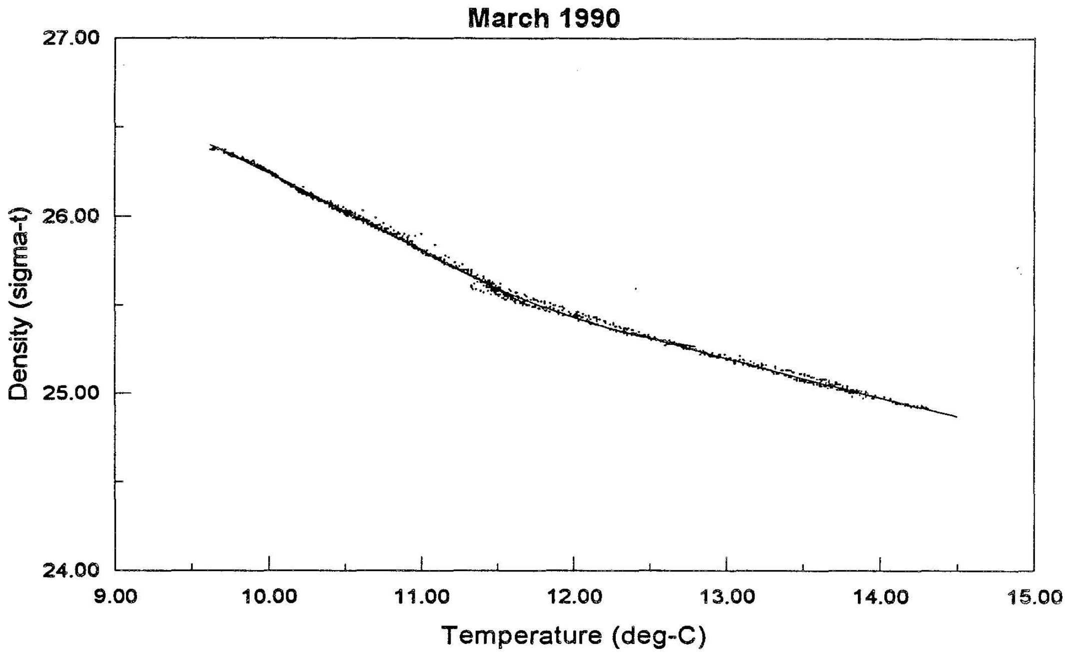


Figure Q-3:
Water Temperature vs. Density, October 1990

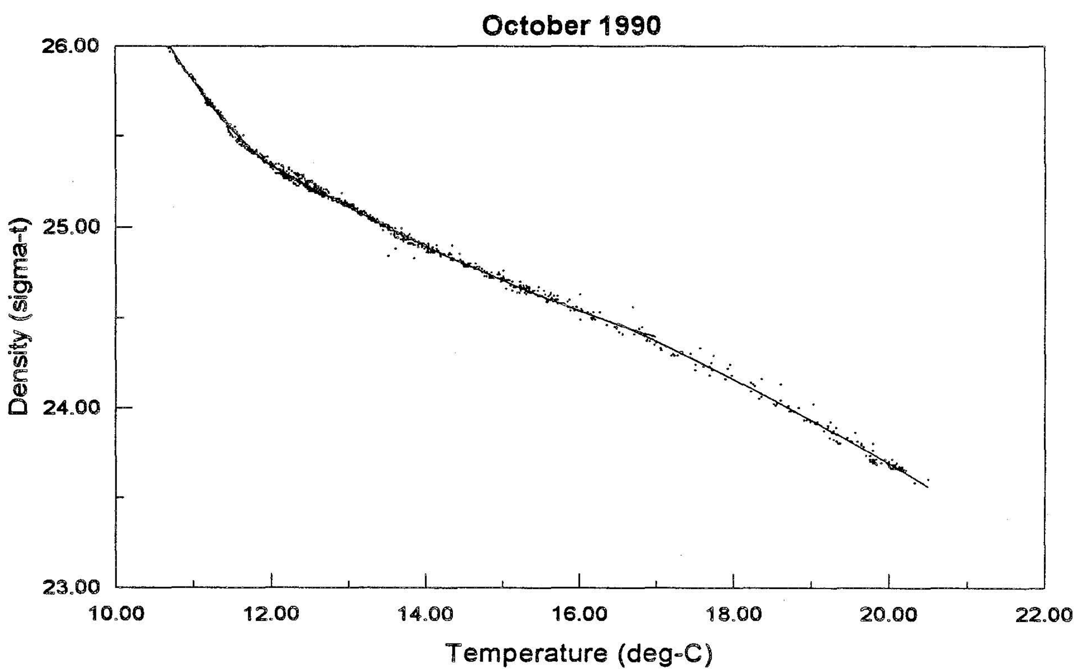


Figure Q-4:
Distribution of the Ratio of Port Spacing to the Buoyancy Length Scale
240 mgd Discharge

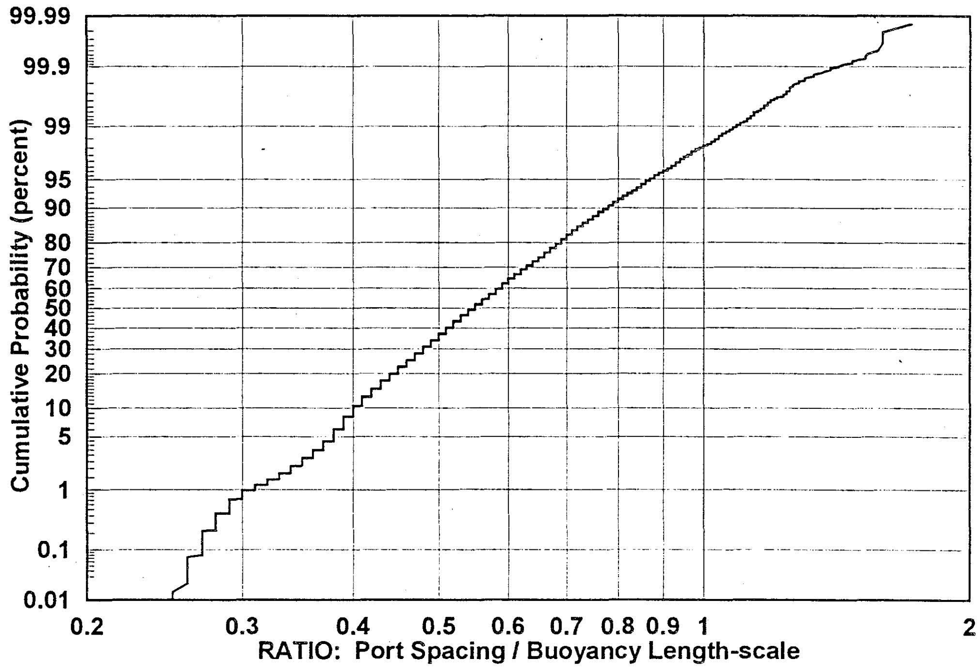


Figure Q-5:
Distribution of the Ratio of Momentum Length-Scale to the Buoyancy Length Scale
240 mgd Discharge

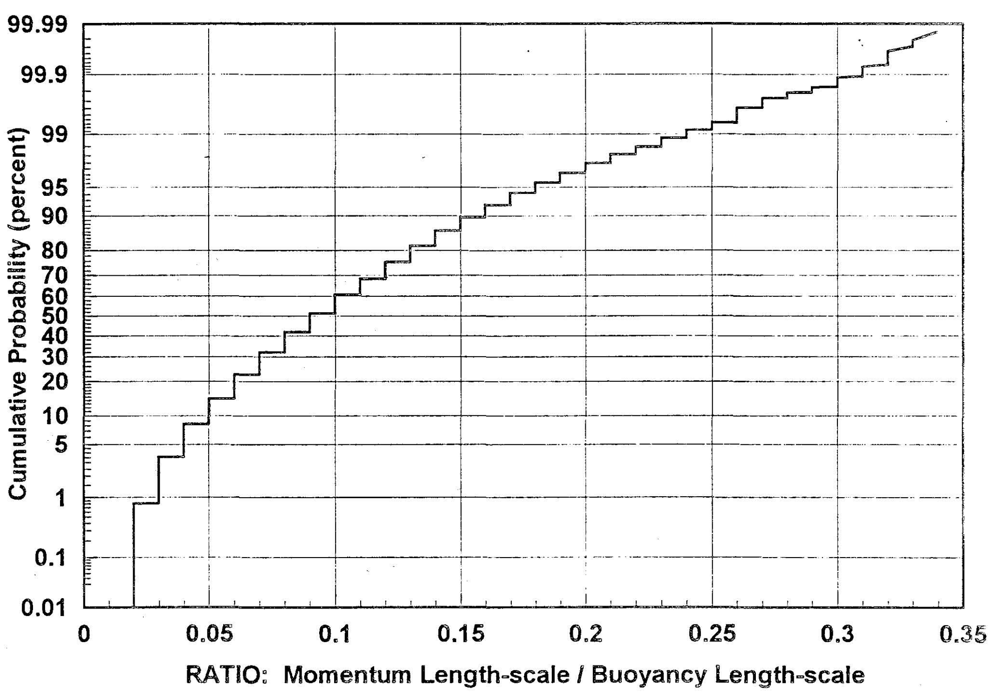


Figure Q-6:
Distribution for Roberts' Froude Numbers 240 mgd Discharge

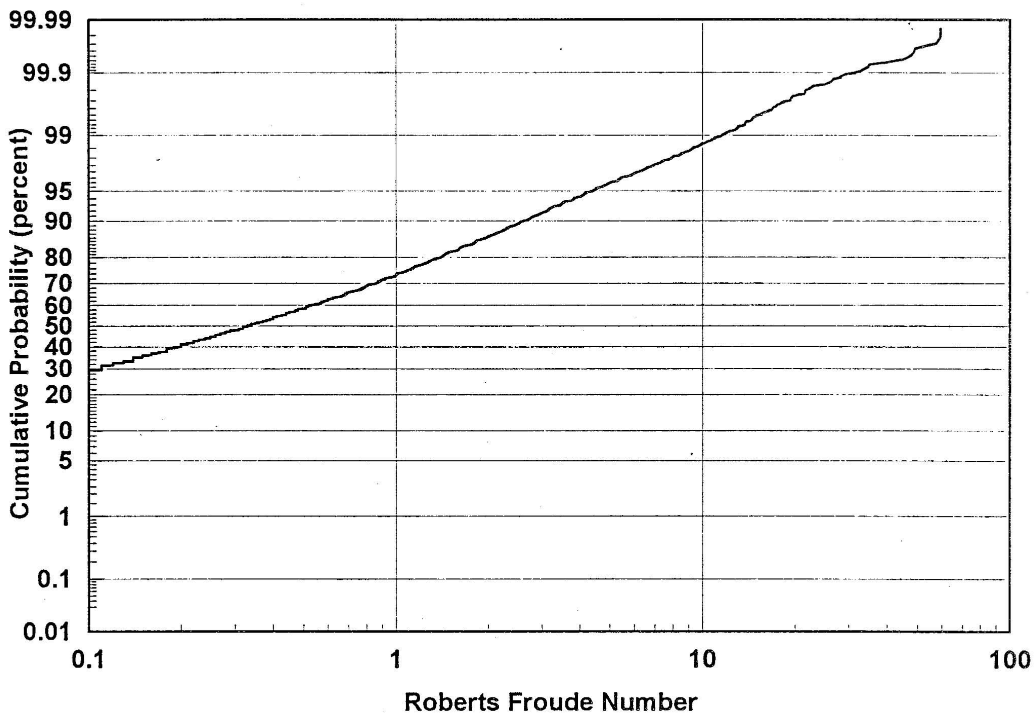


Figure Q-7:
Time-Series of Flux-Averaged Initial Dilution
240 mgd Discharge with Currents

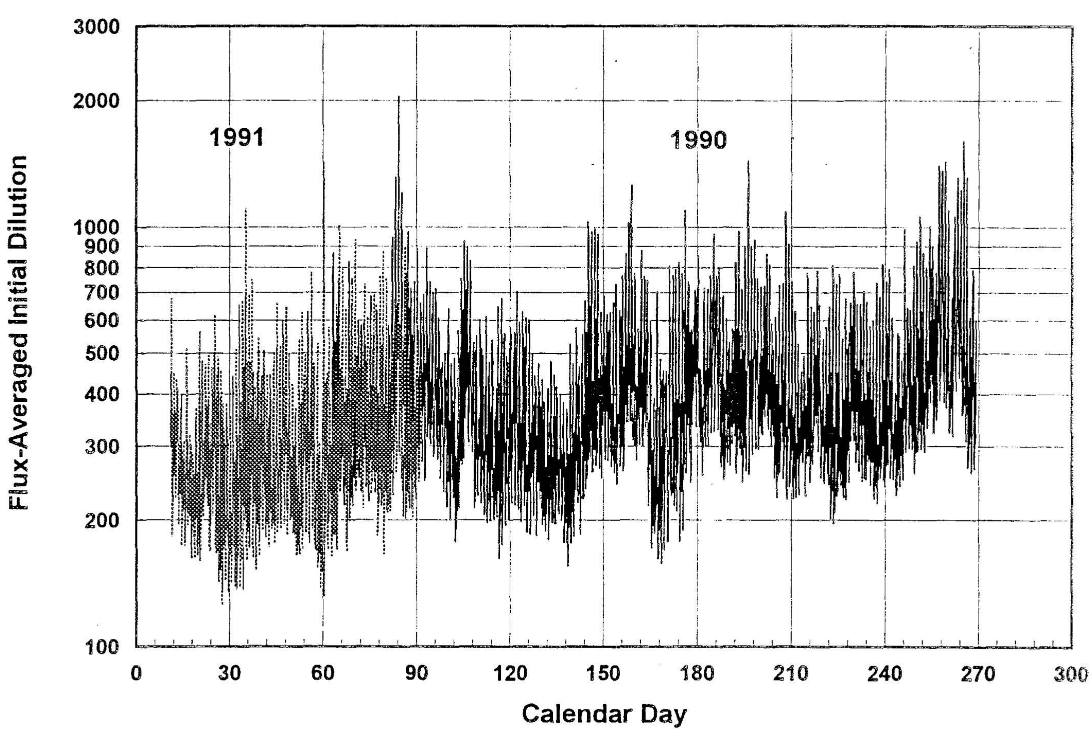


Figure Q-8:
Probability Distribution of Flux-Averaged Initial Dilution
240 mgd Discharge with and without Currents

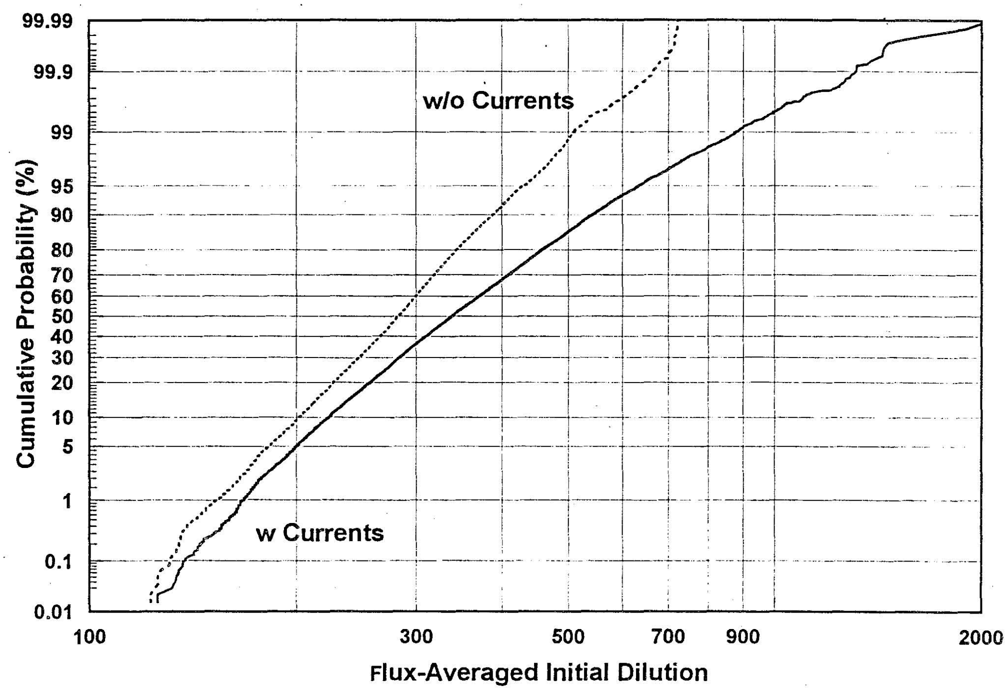


Figure Q-9:
Running 30-Day Average Initial Dilution, 1990-1991
240 mgd Discharge with and Without Currents

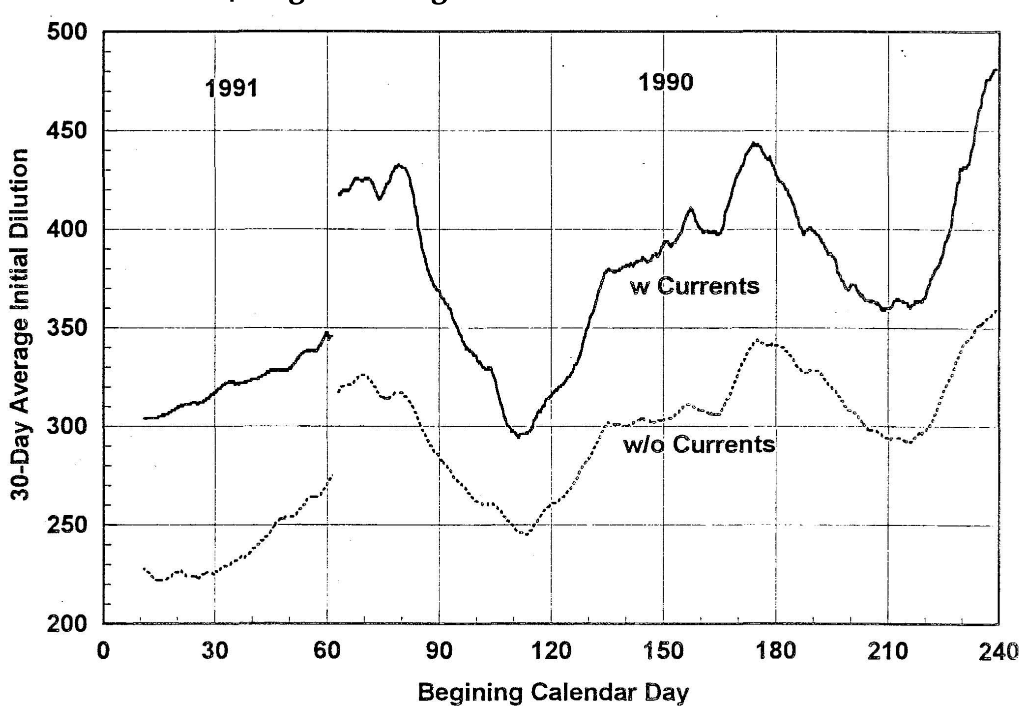


Figure Q-10:
Time-Series of Flux-Averaged Initial Dilution
205 mgd Discharge with Currents

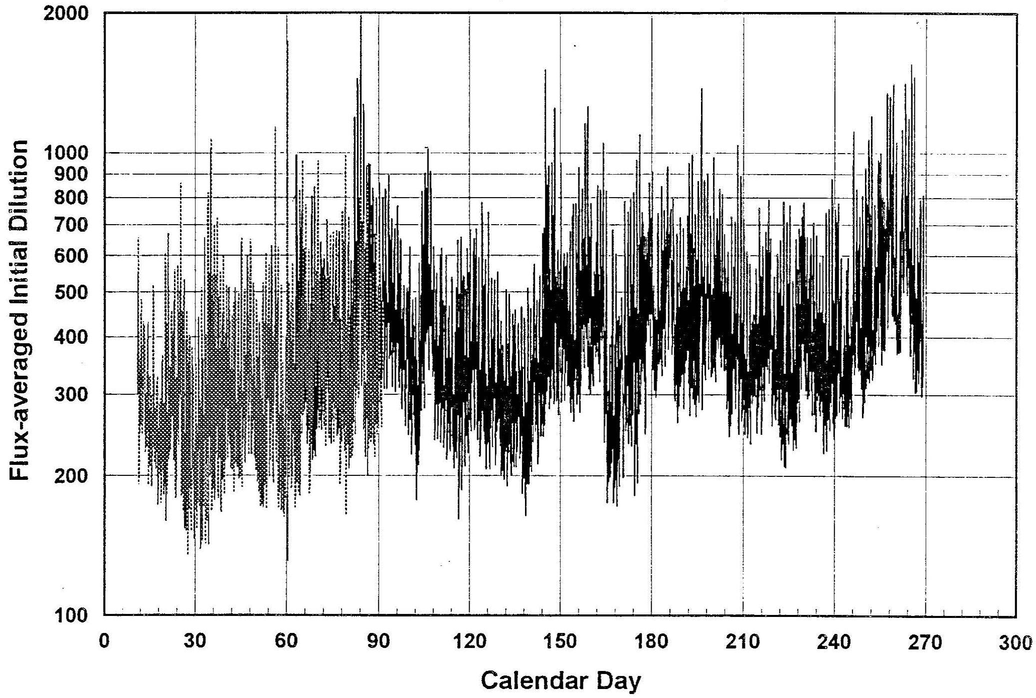


Figure Q-11:
Probability Distribution of Flux-Averaged Initial Dilution
205 mgd Discharge with and without Currents

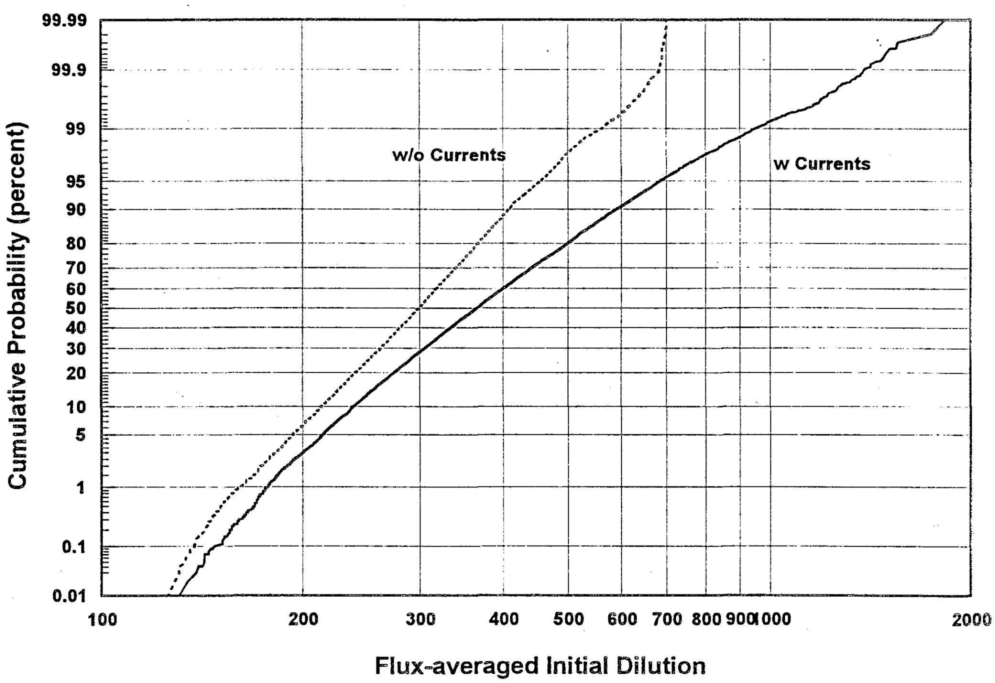


**Figure Q-12:
Running 30-Day Average Initial Dilution, 1990-1991
205 mgd Discharge with and Without Currents**

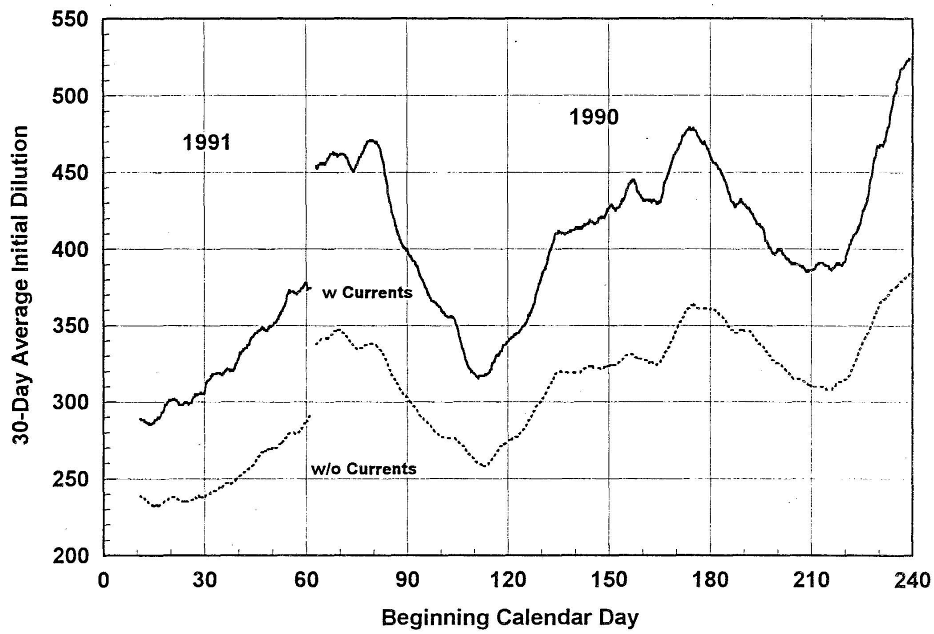


**Figure Q-13:
Probability Distribution of Flux-Averaged Initial Dilution
205 mgd and 240 mgd Discharges with Currents**

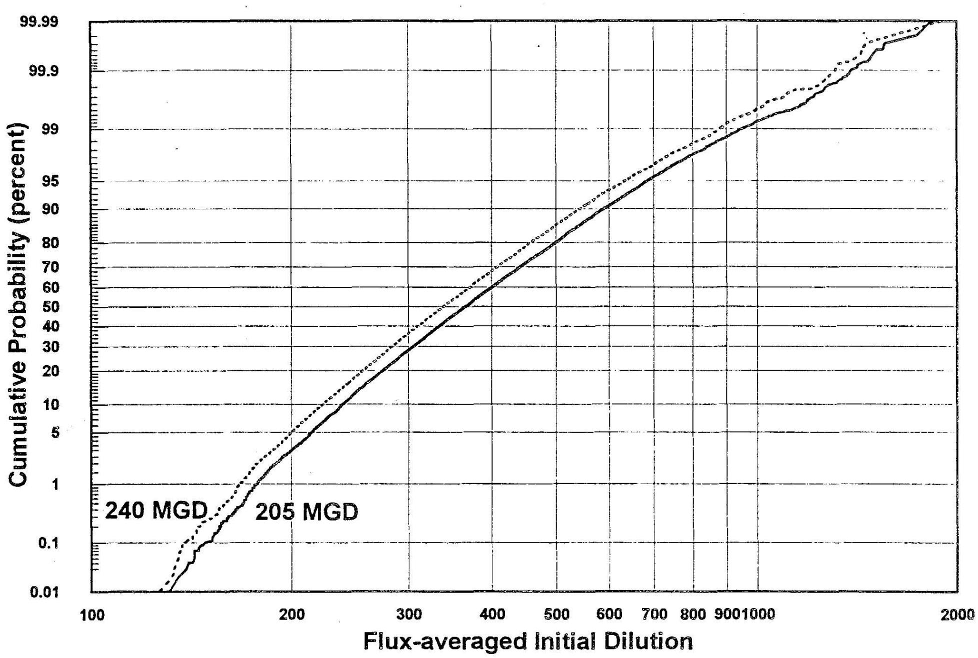


Figure Q-14:
Time-Series Flux-Averaged Initial Dilution
Variable Discharge vs. Constant Discharge with Currents

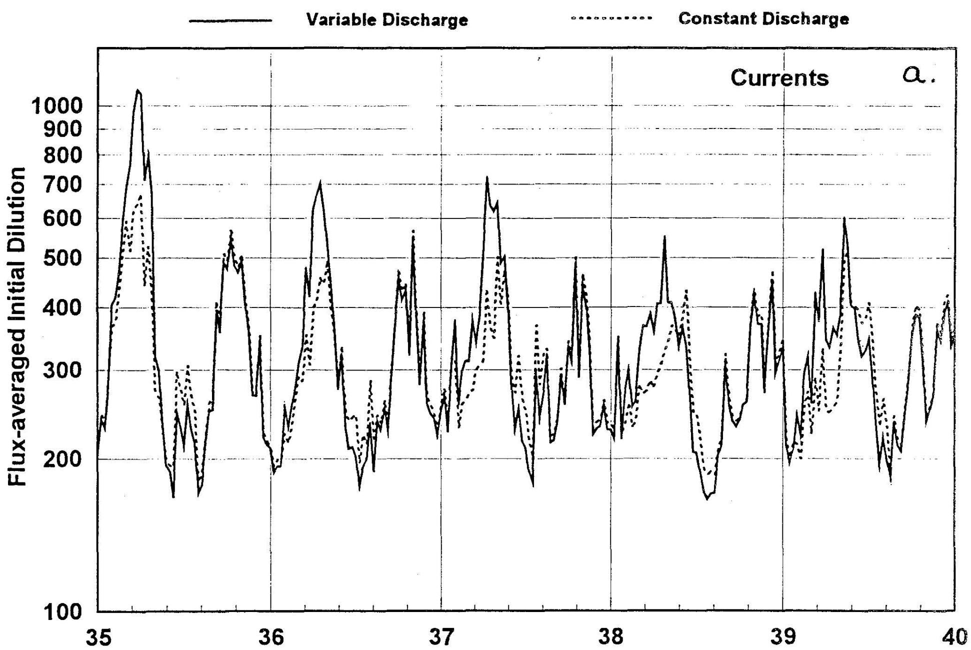


Figure Q-15:
Time-Series Flux-Averaged Initial Dilution
Variable Discharge vs. Constant Discharge without Currents

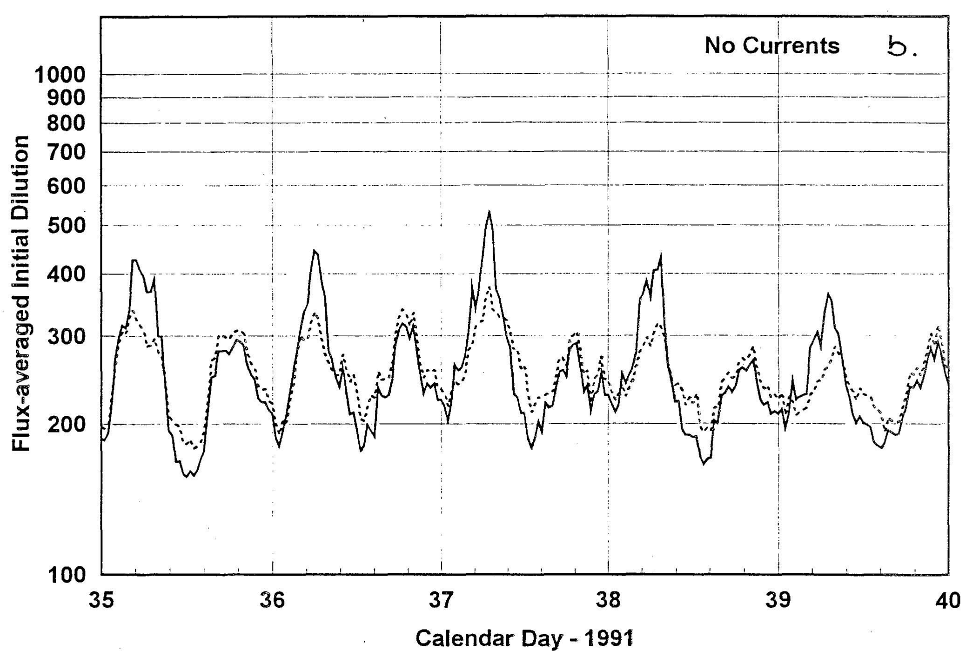


**Figure Q-16:
Variability of 30-Day Average Initial Dilution
240 mgd Discharge without Currents**

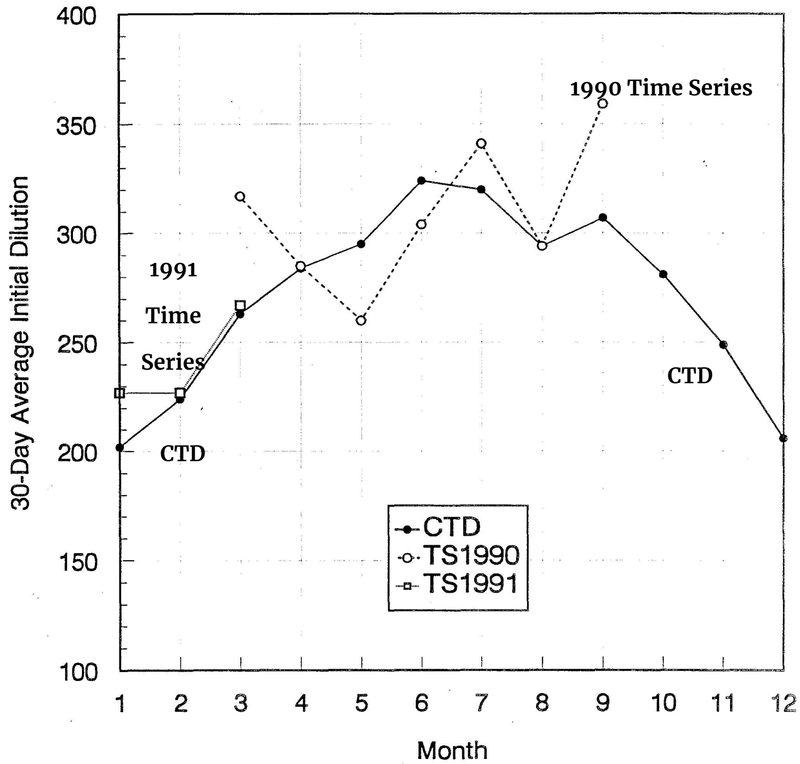


**Figure Q-17:
Variability of 30-Day Average Initial Dilution
205 mgd Discharge without Currents**

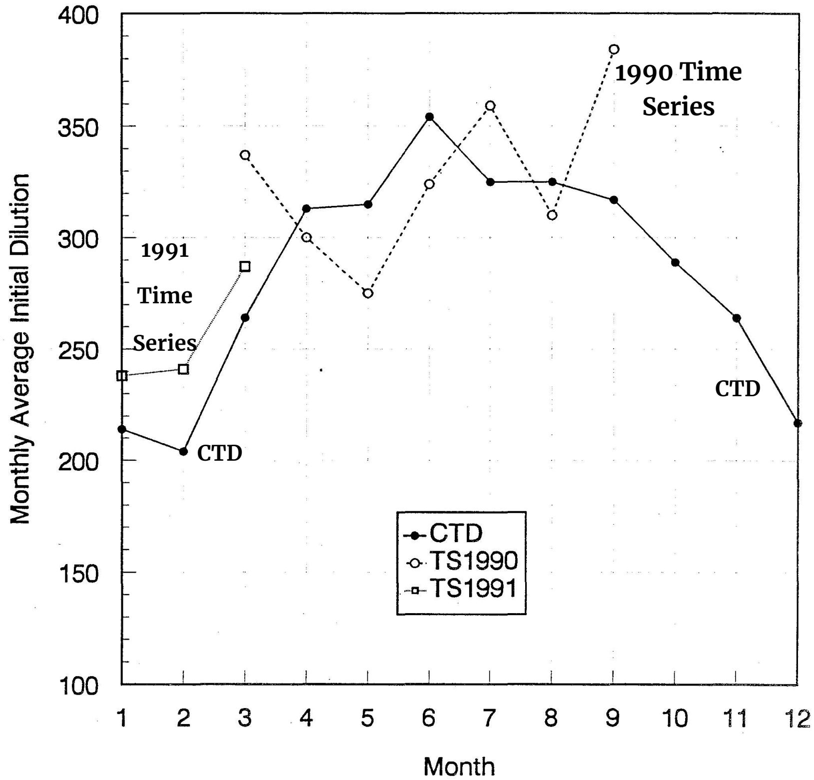
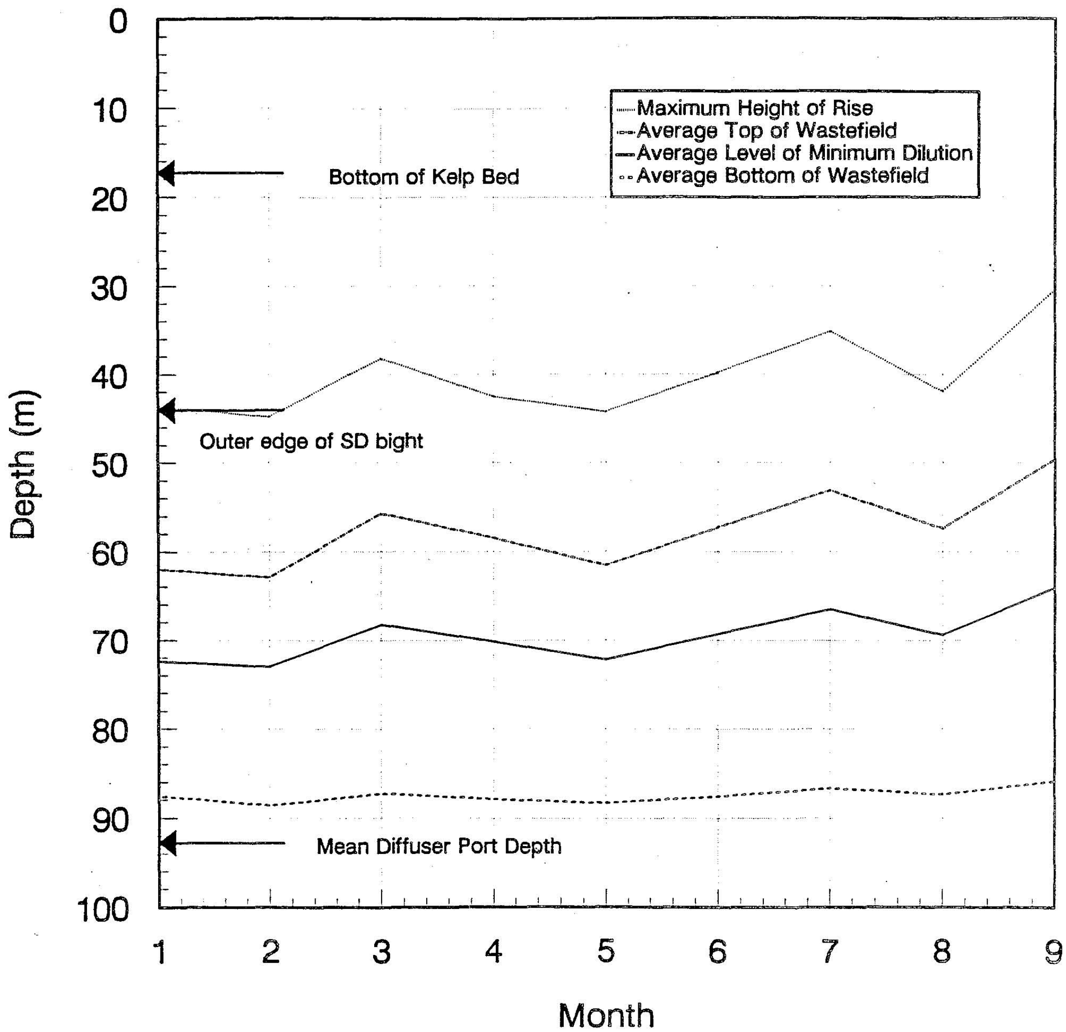


Figure Q-18:
Monthly Average Wastefield Depth at Completion of Initial Dilution
205 mgd Discharge



APPENDIX R

DISSOLVED OXYGEN DEMAND

City of San Diego
Public Utilities Department

March 2022

Table of Contents

Section **Page**

List of Figures

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Acronyms and Abbreviations

°C	degrees Celsius
ATSD	EPA Amended 301(h) Technical Support Document
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
CBOD	carbonaceous (carbon-associated) biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
$CBOD_L$	ultimate carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
City	City of San Diego
cm/sec	centimeters per second
CTD	conductivity, temperature, and depth
DO	dissolved oxygen
DO_a	ambient dissolved oxygen
DO_f	final dissolved oxygen
EPA	United States Environmental Protection Agency
hr	hour
IDOD	immediate dissolved oxygen demand
m	meters
m/sec	meters per second
mg/L	milligrams per liter
mgd	million gallons per day
NBOD	nitrogenous (nitrogen-associated) biochemical oxygen demand
$NBOD_5$	5-day nitrogenous biochemical oxygen demand
$NBOD_L$	ultimate nitrogenous biochemical oxygen demand
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan, Ocean Waters of California
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
ZID	zone of initial dilution

R.1 BACKGROUND

Dissolved oxygen (DO) computations presented in this appendix were originally presented in the City of San Diego's (City's) 1995 301(h) waiver application. Effluent concentrations of total suspended solids in the Point Loma Wastewater Treatment Plant (PLWTP) effluent have declined significantly since the original version of this appendix was prepared in 1995. While PLWTP effluent BOD concentrations have risen during the past several years as a result of successful conservation efforts, the original 1995 DO deficit computations remain valid due to the number of compounding conservative assumptions implicit within the 1995 DO computations. Additionally, receiving water conditions addressed in the City's original 1995 301(h) application (including initial dilution, receiving water BOD, and receiving water DO) remain valid. For these reasons, the DO deficit computations presented in the original 1995 301(h) application (presented again herein) remain useful for identifying the maximum potential "upper bound" of DO depression that could occur in the unlikely event that a series of worst-case effluent and receiving water conditions simultaneously occur. Point Loma Ocean Outfall (PLOO) receiving water data collected to date continue to show consistent compliance with State of California receiving water quality requirements related to DO, and the theoretical "upper bounds" of DO depression computed herein have not been observed.

This appendix presents calculations of the DO deficit due to immediate dissolved oxygen demand[1] (IDOD) and the farfield biochemical oxygen demand (BOD)[2] due to the release of oxygen demanding waste materials from the PLOO. Methods for calculating IDOD and BOD are presented, along with corresponding input data.

Observed "worst case" ambient DO and temperature data along with calculated initial dilution and height-of-rise-to-the-trapping-level values are used herein to determine the DO depression due to the IDOD. Results of this analysis showed that the IDOD would not depress the ambient receiving water DO more than 0.8%. Effluent can exert oxygen demand through IDOD, carbonaceous BOD (CBOD), and nitrogenous BOD (NBOD). Two means were used to assess PLOO outfall effects on receiving water DO. First, procedures established in the United States

---

1 Clean Water Act Section 301(h) requirements established in 1994 (*Federal Register*, Volume 59, Number 152, August 9, 1994, 40 Code of Federal Regulations (CFR) 125), made use of IDOD as a parameter to characterize potential effects of oxygen-demanding wastes. IDOD is no longer utilized in assessing wastewater, and *Standard Methods for the Examination of Water and Wastewater* has eliminated the IDOD test since the 14th edition (1975). The use of IDOD herein is included for purposes of complying with Clean Water Act 301(h) requirements promulgated within 40 CFR 125, but BOD, CBOD and DO are preferred parameters for quantifying oxygen-demands within wastewater.

2 BOD is a generic term used herein to describes the amount of oxygen consumed as organic matter is decomposed and inorganic matter is oxidized. Subsets of BOD includes CBOD and NBOD. CBOD is the BOD from the decomposition of organic (carbon-containing) compounds as well as the oxidation of inorganic compounds such as ferrous iron and sulfide. NBOD is the BOD associated with the oxidation of reduced forms of nitrogen (e.g., ammonia) to nitrite and nitrate by autotrophic bacteria. The PLOO National Pollutant Discharge Elimination System (NPDES) permit (Order No. R9-2017-0007) establishes oxygen demand effluent limitations on the basis of 5-day biochemical oxygen demand (BOD_5). BOD_5 is the total amount of oxygen consumed (CBOD and NBOD) over a 5-day period at a temperature of 20 degrees Celsius (°C) as organic matter is decomposed or reduced by bacteria and other organisms.

Environmental Protection Agency (EPA) *Amended 301(h) Technical Support Document* (ATSD) were used to calculate DO depression.[3] Using the ATSD procedures, total DO depression caused by IDOD and BOD is conservatively estimated at 2.8%. Second, a time-history analysis is used to calculate theoretical initial dilution values required to depress receiving water DO concentrations by 10%.

For assumed "worst case" PLOO conditions (based on a series of compounding conservative assumptions), an initial dilution of approximately 100:1 would be required to cause a 10% DO depression within the PLOO discharge zone.[4] As documented in Appendix Q, minimum month PLOO initial dilutions at a 240-million-gallon-per-day (mgd) flow exceed this 100:1 value by a factor of two, and typical initial dilutions for the Point Loma outfall are far in excess to the minimum dilutions required to prevent a 10% depression of receiving water DO.

R.2 INTRODUCTION

R.2.1 Ocean Plan

The *Water Quality Control Plan, Ocean Waters of California* (Ocean Plan)[5] requires that:

The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials.[6]

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3 *Amended 301(h) Technical Support Document*, Publication EPA 842-B-94-007 (EPA, 1994).

4 Average annual concentrations of BOD_5 in the PLWTP effluent have historically ranged from approximately 100 mg/L to slightly over 130 mg/L. Present-day PLWTP BOD_5 concentrations are in this upper range; the year 2020 PLWTP average annual effluent BOD_5 concentration was 132 mg/L. During the 1990s, industrial BOD loads to the San Diego Metropolitan Sewerage System were significantly reduced as canneries and major industries shut down or reduced loads of discharged organic material. Per capita domestic BOD loads have remained relatively constant during the past 25 years, but in recent years domestic BOD loads have been concentrated into a reduced PLWTP influent flow as a result of successful regional water conservation efforts. While BOD_5 concentrations in the 2020 PLWTP are presently higher than concentrations in 1995, the 1995 DO computations remain valid due to a number of compounding conservative assumptions built into the 1995 DO depression estimates. Conservative assumptions used in the 1995 computations include (1) assuming a PLWTP flow of 240 mgd, (2) assuming lowest historical receiving water DO concentrations, (3) assuming that nitrogenous BOD/total BOD ratios are approximately a factor of six higher than observed averages, (4) assuming zero DO in the PLWTP effluent, (5) assuming a PLWTP effluent IBOD that is significantly higher than actual measured values, and (6) assuming receiving water temperatures are at their maximum (and thus decay rates are at the maximum). As a result of these compounding conservative assumptions, the 1995 DO depression computations remain valid for characterizing maximum theoretical receiving water DO depression as a result of the discharge of oxygen-demanding PLWTP effluent.

5 The current version of the Ocean Plan was adopted by the State Water Resources Control Board on August 7, 2018 and became effective on February 4, 2019.

6 Requirement II.D.1 on page 7 of the 2019 Ocean Plan.

Mathematically, this Ocean Plan requirement can be expressed as:

$$\frac{\Delta DO(z_m)}{DO_a(z_m)} \leq 0.10 \qquad Equation\ R-1$$

where: $\Delta DO(z_m)$ = DO depression due to the oxygen demand of discharged waste at the depth, z_m, and

$DO_a(z_m)$ = concentration of DO in the ambient water at the depth z_m.

The oxygen depressions associated with the oxygen demand of the wastewater are proportional to the concentrations of the effluent IDOD, the effluent BOD in the wastefield, and the difference between the DO concentration in the ambient receiving water and in the effluent. The magnitudes of the depressions associated with each of these factors are proportional to their respective concentrations in the plume/wastefield. The latter are inversely proportional to the volumetric initial dilution, S_a:

$$\frac{\Delta DO}{DO_a} \propto \left\{\frac{IDOD, BOD}{DO_a \times S_a}\right\} \qquad Equation\ R-2$$

R.2.2 Dissolved Oxygen - Critical Period

As part of pre-construction studies of ocean conditions for the PLOO outfall extension, time-series of initial dilutions were calculated from corresponding time-series measurements of the ocean currents and the density stratification of the water column (see Appendix Q - Initial Dilution). Minimum DO concentrations monitored over several years were superimposed on computed initial dilutions during critical periods to create a paired DO/stratification data base.

Using this conservative approach, the period of most critical DO depression was estimated by assuming that the minimum ambient DO (as measured in a specific month from several years of data collected from hydrographic surveys), may occur simultaneously with the minimum initial dilution for that month. This is a conservative assumption since it is unlikely that both extremes will occur simultaneously. Additionally, available hydrographic data and initial dilution simulations suggest that the two quantities are negatively correlated, i.e., warm water temperatures are associated with low initial dilutions but higher ambient DO concentrations. City of San Diego monitoring data collected in the vicinity of the Point Loma outfall between 1991 and 1994 were used to identify the minimum DO concentrations for each month.

DO concentrations at a depth of 82 meters (m) were used since this depth approximately corresponds to the layer of minimum dilution within the wastefield (i.e., the "centerline" of the wastefield for the smallest initial dilutions). Normalized values (based on the minimum value) of the product of the minimum initial dilution and the minimum DO for each month, are shown in Table R-1.

Using this data base (see Table R-1), the critical period for DO depression is January through April. Subsequent DO monitoring by the City of San Diego during the past two decades continue to show that the January through April months have the lowest DO concentrations at depth.[7]

**Table R-1:
Ranking of Months for Critical DO Period**

Month	Relative Value [A]	Rank
January	1.159	4
February	1.000	1
March	1.004	2
April	1.021	3
May	1.214	6
June	1.171	5
July	1.988	8
August	1.223	7
September	2.057	9

Table R-1 Notes:

A Relative values shown in Table R-1 are computed as: $(DO_{min} \times Sa_{min}) / (DO_{min\text{-}Feb} \times Sa_{min\text{-}Feb})$

R.3 IMMEDIATE DISSOLVED OXYGEN DEMAND

The immediate DO calculation was carried out using the method described on pages B-14 to B-18 in the ATSD. The DO concentration following initial dilution can be predicted using the following equation (Equation B-6 from the ATSD):

$$\Delta DO\% = DO_a + \frac{DO_e + IDOD + DO_a}{S_a} \qquad Equation\ R-3$$

where: DO_f = Final DO concentration of receiving water (milligrams per liter (mg/L)) at the plume trapping level,

DO_a = Affected ambient DO concentration (mg/L) immediately up current of the diffuser averaged over the tidal cycle (12.5 hours) and from

7 See Appendix P (Oceanography) and Section II.B of the Large Applicant Questionnaire, Volume II.

the diffuser port depth to the trapping level,

DO_e = Effluent DO (mg/L),

$IDOD$ = Immediate DO demand (mg/L),

S_a = Flux averaged initial dilution, and

DO_p = Ambient DO (mg/L) at diffuser port depth (93 m).

The percent depression of DO due to wastewater is given by Equation B-9 of the ATSD, as follows:

$$\Delta DO\% = 100 \cdot \frac{DO_t - DO_e + IDOD}{DO_t \cdot S_a} \qquad Equation\ R-4$$

where: DO_t = Ambient DO concentration (mg/L) at the trapping level

The IDOD is a difficult value to measure because the chemical test often gives unreliable answers. As a result of this inconsistency, *Standard Methods for the Examination of Water and Wastewater* has eliminated the IDOD test since the 14th edition (1975). Based on PLOO travel times and 5-day BOD (BOD_5) values, the ATSD (Table B-3) recommends use of IDOD values of 3 to 4 mg/L. Testing performed on the PLOO effluent during 1994 yielded IDOD values ranging from 0.45 to 1.74 mg/L, and no IDOD testing has occurred since that date. (See response to Large Applicant Questionnaire Section II.B.4(b) in Volume II.) To be conservative, the 4 mg/L EPA-recommended value is used in the DO depression calculations in lieu of the lower IDOD values measured in 1994.

Final dissolved oxygen (DO_f) concentrations were calculated using conductivity, temperature, and depth (CTD) data collected by Engineering-Science during 1990-1991. These data remain valid, and are appropriate for use in assessing DO depression because the data were collected before the extended PLOO was constructed (and thus observed ambient DO concentrations were not influenced by the PLOO discharge).

To ensure that DO values for the lowest initial dilution periods were properly correlated with depth, temperatures recorded at both the port and calculated trapping level were noted. These temperatures were then referenced using the CTD data to get the DO at those depth positions and points in time. Because of internal tides, the DO as measured by the depth can vary rapidly in time, and comparing DO directly to the depth of the trapping level would lead to erroneous results. On the other hand, since temperature and DO do not vary rapidly in time, referencing DO to temperature is preferred.

Table R-2 presents the correlated initial dilution, DO, and temperature data used in the DO depression computation. Using Table R-2, given water temperatures for the port and trapping level on a given calendar day, one can reference these to DO values at the two levels. The ambient dissolved oxygen (DO_a) becomes the DO, "...averaged...from the diffuser port depth to the trapping level", as suggested in the ATSD. The ATSD lists two additional requirements in the definition of DO_a. The first requirement, that the "...dissolved oxygen concentration [be measured] immediately up current of the diffuser..," is met because the CTD data measurements were taken before the outfall was extended. The second, where the DO is "... averaged over the tidal cycle (12.5 hours)...," is met by tagging the DO with temperature, as discussed above, to remove the variability with depth.

Table R-2:
Summary of Data Used to Compute DO Depression
240 mgd PLOO Discharge

Date		Initial Dilution S_a	Temperature (°C)		DO (mg/L)	
			At Port	At Trapping Level	At Port	At Trapping Level
1990	Mar. 7	287 : 1	10.39	10.85	4.23	5.37
	Apr. 17	253 : 1	10.48	10.87	4.30	4.78
	May 23	230 : 1	9.72	10.24	3.65	4.47
	Jun. 20	355 : 1	9.51	10.03	5.23	5.60
	Jul. 25	238 : 1	10.90	12.21	4.35	5.20
	Aug. 29	416 : 1	10.67	11.07	5.60	6.08
	Sept. 27	409 : 1	11.32	11.55	3.99	4.68
1991	Jan. 26	275 : 1	12.20	13.14	6.60	7.15
	Feb. 7	212 : 1	10.87	11.49	4.60	5.83
	Mar. 7	260 : 1	10.23	10.68	4.15	5.00
	Apr. 7	258 : 1	9.97	10.53	3.63	5.18

Using the above data as input, Table R-3 presents computed DO following initial dilution for the 1990-1991 (pre-discharge) database. As shown in Table R-3, the largest DO change occurs under the February 7, 1991 conditions, where DO is reduced from 5.22 mg/L to 5.17 mg/L. The maximum observed percentage DO depression (0.8%) occurs for the February 7 and May 23 data points.

Table R-3:
"Worst Case" Dissolved Oxygen Immediately Following Initial Dilution [A]
240 mgd PLOO Discharge

Date		Initial Dilution S_a	Receiving Water Dissolved Oxygen Concentration [A] (mg/L)				ΔDO (%)
			DO_p [B]	DO_t [C]	DO_a [D]	DO_f [E]	
1990	Mar. 7	287 : 1	4.23	5.37	4.80	4.77	0.6
	Apr. 17	253 : 1	4.30	4.78	4.54	4.50	0.7
	May 23	230 : 1	3.65	4.47	4.06	4.03	0.8
	Jun. 20	355 : 1	5.23	5.60	5.42	5.39	0.5
	Jul. 25	238 : 1	4.35	5.20	4.78	4.79	0.7
	Aug. 29	416 : 1	5.60	6.08	5.84	5.81	0.4
	Sept. 27	409 : 1	3.99	4.68	4.33	4.31	0.5
1991	Jan. 26	275 : 1	6.60	7.15	6.88	6.84	0.6
	Feb. 7	212 : 1	4.60	5.83	5.22	5.17	0.8
	Mar. 7	260 : 1	4.15	5.00	4.58	4.54	0.7
	Apr. 7	258 : 1	3.63	5.18	4.41	4.37	0.7

Table R-3 Notes:

A Based on simultaneous occurrence of the following worst-case conditions: PLOO discharge flow of 240 mgd, PLWTP effluent IDOD of 4.0 mg/L, PLWTP effluent DO concentration of zero, and minimum month PLOO initial dilution of 204:1. Actual receiving water DO concentrations would be expected to be greater than the "worst case" scenarios described above.

B DO_p is the ambient DO at the diffuser port depth (93 m).

C DO_t is the ambient DO concentration at the trapping level.

D DO_a is the affected ambient DO concentration immediately up current of the diffuser averaged over the tidal cycle (12.5 hours) and from the diffuser port depth to the trapping level.

E DO_f is the final DO concentration of receiving water at the plume trapping level.

R.4 FARFIELD DISSOLVED OXYGEN DEMAND

R.4.1 Background

The preceding section discussed the reduction in the concentration of DO in the wastefield due to: (1) the chemical oxidation of reduced compounds in the effluent at the time of discharge and, (2) the difference in DO concentrations in the effluent and the ambient receiving water. These depressions occur during the time the initial dilution process takes place.

Organic materials in the effluent contain carbon and nitrogen that can serve as a source of energy and nutrients for bacteria. Over time, bacteria can convert this material into bacterial cells, consuming additional DO in the process. BOD represents the amount of oxygen consumed in this process, per unit volume of effluent. The BOD includes both CBOD and NBOD. The rates of oxygen consumption differ for CBOD and NBOD demands.

The rate of consumption of each type of BOD, and the corresponding rate of demand of DO, can be represented by a first-order rate equation:

$$\frac{d(C_{BOD})}{dt} = -k \cdot C_{BOD} = \frac{d(DO)}{dt} \qquad Equation\ R-5$$

where: C_{BOD} = concentration of either type of BOD (mg/L)

k = first-order decay rate for the corresponding material (e.g., day^{-1})

While the depressions associated with the IDOD and the difference between the DO concentrations in the ambient water and the effluent are established by the time the initial dilution process is finished, the reduction associated with the BOD occurs as the wastefield is carried away by the ocean currents. The magnitude of this reduction depends on the BOD demand of the effluent, the rate at which this demand occurs, and the amount of DO available in the wastefield. The rate of oxygen demand varies with water temperature through the decay rate, k (which increases with increasing temperature), and the concentration of BOD. The latter declines with the passage of time, as the materials associated with the BOD are converted into bacterial cells. Meanwhile, the amount of DO available in the wastefield increases with the passage of time due to mixing of the wastefield with the surrounding ambient water. As a result of these competing processes, the DO reduction reaches a maximum at some time after completion of the initial dilution process.

R.4.2 Approach and Methodology

The time-dependent DO deficiency in the wastefield due to oxygen demanding wastewater materials, ΔDO_w, is:

$$\Delta DO_w = DO_w(t) - DO_t = -\left\{\frac{\Delta O_2^{eff} + \Delta O_2^{IDOD} + \Delta O_2^{BOD}(t)}{D_s(t)}\right\} \qquad Equation\ R-6$$

where: $DO_w(t)$ = DO concentration in the wastefield at the time, t (mg/L)

DO_t = DO concentration in the ambient surrounding water at the wastefield depth (mg/L)

ΔO_2^{Eff} = DO reduction due to the difference between the DO concentration in the effluent and the DO concentration in the ambient water [e.g. $(DO_e - DO_t)/S_a$]

ΔO_2^{IDOD} = DO demand due to effluent IDOD (mg/L)

$\Delta O_2^{BOD}(t)$ = DO demand at time, t, due to the effluent BOD (mg/L)

$D_s(t)$ = subsequent dilution of the wastefield due to oceanic mixing

The above equation does not include the effects of the entrainment of deeper, colder, ambient water, with lower DO values, into the plume. These effects are excluded from the requirements of the Ocean Plan. In keeping with the example in the section on IDOD (equation B-9, Appendix B, ATSD), the calculations are carried out as though the concentration of ambient DO entrained into the plume during initial dilution is the same as at the trapping level (i.e., $DO_a = DO_t$).

The quantities ΔO_2^{Eff} and ΔO_2^{IDOD} were calculated in the preceding section for an annual average discharge rate of 240 mgd. In combination, they varied from about 0.03 to 0.06 mg/L at the completion of the initial dilution process (for the lowest monthly initial dilution and the lowest monthly ambient DO concentrations).

The oxygen consumption associated with the BOD of the wastewater in the wastefield, $\Delta O_2^{BOD}(t)$ is obtained by integration of the rate equation for oxygen consumption (presented above) for the carbon- and nitrogen-associated BOD:

$$\Delta O_2^{BOD} = \Delta CBOD_L \cdot (1 - e^{-k_c t}) + \Delta NBOD_L \cdot (1 - e^{-k_N t}) \qquad Equation\ R-7$$

where: $\Delta CBOD_L$ = carbon-associated BOD concentration (above ambient) at completion of the initial dilution (mg/L)

$\Delta NBOD_L$ = nitrogen-associated BOD concentration (above ambient) at completion of the initial dilution (mg/L)

k_C = decay rate for carbon-associated BOD (day^{-1})

k_N = nitrification rate coefficient (day^{-1})

t = elapsed time since completion of initial dilution (days)

R.4.3 Input Data

A solution to the equation for ΔDO_w requires information on the parameters, IDOD, $\Delta CBOD_L$, $\Delta NBOD_L$, k_C, k_N, and the time-dependent subsequent dilution, $D_s(t)$. Conservative estimates for each of these parameters are presented below.

Initial Dilution. The concentration of CBOD and NBOD in the wastefield, and the magnitude of the DO reduction associated with the IDOD, are related to the concentration of CBOD, NBOD, and IDOD in the effluent and the flux-averaged initial dilution. The results of simulations of the initial dilution achieved by the PLOO diffuser system are discussed in detail in Appendix Q. The lowest initial dilutions were associated with the period from January through March, and the highest initial dilutions occurred in the late summer to early fall.

A total of 13,757 simultaneous measurements of ocean currents and density structure of the water column (through the water temperatures) were made between January and March, 1991, and March and September, 1990. Although ambient currents were recorded simultaneously with the density structure information, the current speed was set equal to zero in calculating the initial dilutions (as required by the Ocean Plan). The initial dilutions calculated from this data set were used for the IDOD calculations above. The 30-day average monthly initial dilutions for an annual average discharge rate 240 mgd are summarized in Table R-4.

Table R-4:
Regulatory 30-Day Average Initial Dilutions - Zero Ocean Currents A
240 mgd PLOO Discharge

Data Set	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
TS [B] (1990-91)	227:1	227:1	267:1	285:1	260:1	304:1	341:1	294:1	359:1
CTD [C] (1990-1994)	202:1	224:1	263:1	284:1	295:1	324:1	320:1	294:1	307:1

Table R-4 Notes:

A Minimum average month initial dilution, as defined in the Ocean Plan (SWRCB, 2019).

B Initial dilutions simulated using time-series measurements from 1990-1991. See Table Q-10 of Appendix Q.

C Initial dilutions simulated from hydrocast (CTD) data from 1990-1994. See Table Q-10 of Appendix Q.

The number of density profiles used in this initial dilution simulation is roughly two orders of magnitude (or more) greater than the number often available for initial dilution calculations. Therefore, the probability of the present data set containing rarely occurring instances of high stratification (resulting in low initial dilutions) is significantly greater. A 10^{th} percentile initial dilution value of 202:1 (see Table Q-7 in Appendix Q) for the 240 mgd PLOO discharge (zero ocean current) is close to the 204:1 minimum month regulatory initial dilution assigned in Order No. R9-2017-0007.

Effluent Biological Oxygen Demand (BOD). PLWTP effluent BOD concentrations have historically ranged from approximately 100 mg/L to 130 mg/L during the past 25 years. A BOD concentration on the higher end of this historic range (121 mg/L) was used in the DO depression computations.[8]

8 As noted in Footnote 4 (see Section R.1), the average annual PLWTP effluent BOD_5 concentration in 2020 was 132 mg/L. While BOD_5 concentrations in the 2020 PLWTP are presently higher than concentrations in 1995, the 1995 DO computations remain valid due to a number of compounding conservative assumptions built into the 1995 DO depression estimates. Conservative assumptions used in the 1995 computations include (1) assuming a PLWTP flow of 240 mgd, (2) assuming lowest historical receiving water DO concentrations, (3) assuming that nitrogenous BOD/total BOD ratios are approximately a factor of six higher than observed averages, (4) assuming zero DO in the

Initial Effluent CBOD and NBOD Concentrations in the Wastefield. BOD measurements are normally measured as the oxygen consumed over a period of 5 days (BOD_5). To estimate CBOD and NBOD, 13 days of measurements of BOD_5 and $CBOD_5$ (i.e., with nitrification inhibited) were conducted on the PLWTP effluent between June 1 and July 27, 1992. These data were used to estimate the ratio of nitrogen-associated BOD_5 ($NBOD_5 = BOD_5 - CBOD_5$) to total BOD_5. Observed ratios ranged from 2.2% to 27.6% (median: 11%; average: 12.4%).

The decay rate (see discussion below) for carbon (k_C) exceeds the nitrification rate (k_N). At the same time, the ratio of ultimate CBOD ($CBOD_L$) to $CBOD_5$ is greater than the ratio of ultimate NBOD ($NBOD_L$) to $NBOD_5$. Therefore, the greatest oxygen demand, per unit BOD_5, will occur for the lowest ratio of $NBOD_5$ to BOD_5.

To conservatively estimate the maximum possible oxygen demand, it was assumed that the $CBOD_5$ is 97.8% of the total BOD_5 of the effluent, and the $NBOD_5$ is 2.2% of the total BOD_5. Thus, the maximum $CBOD_5$ is estimated to be 118.3 mg/L (121 x 0.978), and the corresponding $NBOD_5$ is estimated to be 2.7 mg/L.

The next step is to convert the BOD_5 values into the corresponding ultimate BOD concentrations (i.e., at the completion of the conversion process to bacterial cells). Thomann and Mueller (1987) estimated the ratio of the $CBOD_L$ to $CBOD_5$ for primary effluent to be 2.84. This conversion factor was used for the calculations, yielding an $CBOD_L$ of 336 mg/L (118.3 x 2.84). Thomas and Mueller also estimated the corresponding ratio for nitrogen-based BOD to be 2.54. Hence, an $NBOD_L$ of 6.8 mg/L (2.7 x 2.54) was used in the calculations.

BOD Decay Rates. The decay rate for CBOD (k_C) can be estimated from the equation (from: Equation B-13, Appendix B, ATSD):

$$k_c = 0.23\ \Theta_c^{(T-20)} \qquad \textit{Equation R}-8$$

where: T = wastefield temperature in °C

Θ_c = temperature correction factor

Fair et al. (1968) suggest Θ_C values of 1.15, 1.11, and 1.047 for temperatures of 5 °C, 10 °C, and 20 °C, respectively. These three pairs of values were represented by a second-order polynomial to estimate the decay coefficient at intermediate water temperatures. At a water temperature of 12.5 °C, the value for Θ_C is estimated to be 1.092. The corresponding value for the decay coefficient, k_C, is then 0.119 day^{-1}, or 0.00495 hr^{-1}.

PLWTP effluent, (5) assuming a PLWTP effluent IBOD that is significantly higher than actual measured values, and (6) assuming receiving water temperatures are at their maximum (and thus decay rates are at the maximum).

The corresponding equation for NBOD (from: Equation B-15, Appendix B, ATSD) is:

$$k_n = 0.1\,\Theta_N^{(T-20)} \qquad Equation\ R-9$$

A value of Θ_N = 1.08 is valid for temperatures between 10 °C and 30 °C (Appendix B, ATSD). At a temperature of 12.5 degrees, the nitrification rate becomes 0.0561/day, or 0.00234/hour.

Water Temperature. As noted earlier, the lowest initial dilutions in the DO/initial dilution database period occurred during January to March, 1991 (3,858 cases). This subset was then sorted by the magnitude of the dilution for the calculation of the decay rates (decay rates are temperature dependent). A second subset was created from this sorted subset, by selecting only the cases with values within 20% of the lowest initial dilution.

The average ambient water temperature at the wastefield depth for this set of low initial dilutions was 11.70 °C. The highest temperature was 12.57 °C; the lowest temperature, 10.81 °C. A temperature of 12.5 °C was used to compute the rate constants for the oxygen depressions associated with effluent BOD. This is a conservative assumption, since the water temperature at any depth in the wastefield will be lower than the ambient water temperature at the same depth outside the wastefield.

Ambient BOD. The BOD of the ambient waters is sufficiently low so that the measured values are within the range of error of the measurement. For the purposes of the DO reduction calculations, we assumed it to be zero (this demand is normally satisfied by vertical diffusion of oxygen in the water column). Therefore, the $\Delta CBOD_L$ and $\Delta NBOD_L$ in the preceding equation can be considered to be equal to the effluent $CBOD_L$ and $NBOD_L$ after initial dilution.

DO at the Completion of Initial Dilution. The oxygen demand due to the IDOD of the effluent and the entrainment of ambient receiving water during the initial dilution process was discussed in the preceding section of this appendix. These values were used as the DO initial conditions in the calculation of the temporal evolution of DO in the wastefield with the passage of time.

Subsequent Dilution. Horizontal mixing (e.g., along surfaces of constant water density) takes place in the ocean due to turbulent diffusion (from the combination of molecular diffusion and shear in the currents). The process is commonly referred to as dispersion. Current shear is associated with eddies present in the flow field. The most effective mixing of a patch of water with the water surrounding it is associated with the set of eddies with dimensions that range up to the size of the patch.

These eddies tend to break down the original patch into ever smaller patches, until the relatively weak process of molecular diffusion becomes effective. On the other hand, eddies with dimensions larger than the patch tend to advect it as a unit rather than producing mixing. The end result is that if turbulent eddies covering a wide range of dimensions are present in the ocean, the eddy diffusivity describing the mixing will increase as the dimension of the dispersed patch grows. Thus, the range of eddy dimensions (length-scales) present in the ocean, and the distribution of kinetic energy among eddies of various length-scales, will determine the characteristics of the eddy diffusivity.

The square-root of the spatial variance (i.e., the standard deviation, σ) of a patch along an axis is often used as a measure of its "dimension" along that axis. If all the eddies present in the area of the patch have dimensions that are smaller than the dimension of the patch, the eddy diffusivity will remain constant in magnitude as the patch dimensions increase. For a patch with initial variance $\sigma^2(0)$ the variance of the patch grows linearly with time:

$$\sigma^2(t) = \sigma^2(0) = 2K_H \cdot t \qquad Equation\ R-10$$

where: $\sigma^2(t)$ = variance (e.g., m^2) of the patch at the time t (e.g., sec)

K_H = horizontal eddy diffusivity (e.g., m^2/sec)

Diffusion characterized by a constant diffusivity is often referred to as Fickian diffusion (it is characteristic of molecular diffusion). However, in the ocean the "diffusivity" associated with the current eddies greatly exceeds that associated with molecular diffusion.

If the range of eddy dimensions is always greater than the dimensions of the patch (at any time during the period of interest), and if the energy input supporting the eddies is supplied to the eddies with the largest dimensions, the rate of growth of the patch dimensions will be proportional to the three-halves power of the time (the variance increases as the cube of the time). This leads to an eddy diffusivity that is proportional to the four-thirds power of the dimensions of the patch, giving rise to the so-called "four-thirds" law for eddy diffusion.

Eddies associated with conditions that lie between these two extremes, or different assumptions about the dynamics of the mixing process, can give rise to other patch growth rates. Okubo and Pritchard (1969) and Okubo (1970) note that in coastal waters, the dimensions of a patch are frequently observed to grow linearly with time. Okubo (1970) observed that this apparent growth rate may be associated with the input of energy into eddies at specific length-scales (e.g., corresponding to the dimensions of the tidal ellipse, etc.).

A linear growth rate in the patch dimensions, and a quadratic growth rate in time of its variance, can be quantified dimensionally by the introduction of a diffusion velocity (v_d). For a point patch, the variance grows as:

$$\sigma^2(t) = (v_d \cdot t)^2 \qquad Equation\ R-11$$

Measurements at a wide range of locations indicate diffusion velocities are typically on the order of 1 centimeter per second (cm/sec) (Okubo and Pritchard, 1969). In general, the patches of interest will not start out at time t=0 as point patches. For example, immediately following the initial dilution process the wastefield will have some width (and corresponding variance $\sigma(0)^2$). Since the initial dilution process is independent of the oceanic mixing process, the initial and subsequent variances are statistically independent.

Therefore, for a representation of diffusion velocity, they can be added to get the variance at the beginning of the wastefield (e.g., time t = 0) as follows:

$$\sigma^2(t) = \sigma^2(0) + (v_d \cdot t)^2 \qquad Equation\ R-12$$

A two-dimensional patch (e.g., an ellipse) will spread in two dimensions. These are often taken as the "spreading" in the "along-current" and "cross-current" directions, since the apparent eddy diffusivities are frequently different in the two directions. The along-current diffusivity is enhanced by the presence of current shear with water depth and vertical mixing. (Okubo and Pritchard, 1969)

For a continuous discharge, however, it is the cross-current eddy diffusivity that produces most of the reduction in the concentration of wastewater in the wastefield. (This occurs because along-current gradients in wastewater concentrations are small.)

If mixing only occurs along surfaces of constant water density (i.e., vertical mixing is negligible), and if the normalized distribution of some tracer (e.g., wastewater) within a patch remains the same (e.g., a Gaussian distribution). The ratio of the concentrations of the tracer within the patch at two different times is equal to the inverse of the ratio of the dimensions of the patch at these times, as follows:

$$\frac{c(t)}{c(0)} = \frac{1}{Dilution} = \frac{\sigma(0)}{\sigma(t)} \qquad Equation\ R-13$$

where: $c(t)$ = concentration of the tracer at time "t"

Horizontal eddy diffusivity was estimated on the basis of plume tracking studies completed by Hendricks and Harding (1974) using measurements of ammonia. These measurements were made as part of a study of phytoplankton response to wastewater nutrients. At the beginning of the study, a parachute drogue was deployed at the approximate depth of the wastefield immediately downcurrent from the original Point Loma outfall (in 60 m of water). Two auxiliary drogues were placed 300 m away from this primary drogue perpendicular to the direction of flow. Measurements of ammonia, nitrite, nitrate, and chlorophyll-α were made at approximately 6-meter intervals between the surface and a depth of 51 m in the water column. These profiles were measured adjacent to the primary drogue, and each of the secondary drogues, at 5-hour intervals over a period of 40 hours. It was assumed that the effects of vertical mixing were negligible, and the reduction in ammonia concentration was due to horizontal mixing.

Figure R-1 presents observed reductions in the peak ammonia concentration in the wastefield plume over this period (from Hendricks and Harding, 1974). The wastefield starts out at time t=0 with an initial variance, $\sigma^2(0)$. The variance describing the cross-wastefield distribution of ammonia in the wastefield is:

$$\sigma^2(0) = \int_0^L p(y) \cdot y^2 \cdot dy \qquad Equation\ R-14$$

where: y = the cross-wastefield position, relative to its centerline

$p(y)$ = normalized concentration distribution of wastewater within the plume

L = half-width of the plume

The initial standard deviation of the distribution of wastewater across the wastefield (σ_0) depends on the strength and direction of the currents, the discharge rate, diffuser leg lengths, and the downstream distance to the initial profile (t = 0). It was estimated to be 349 m based on the relative concentrations at the center drogue and side drogues (at t = 5 hours), and the decline in the peak concentration between the first two samplings (t = 0 and t = 5 hours).

Figure R-1: Diffusion Velocity Characteristics

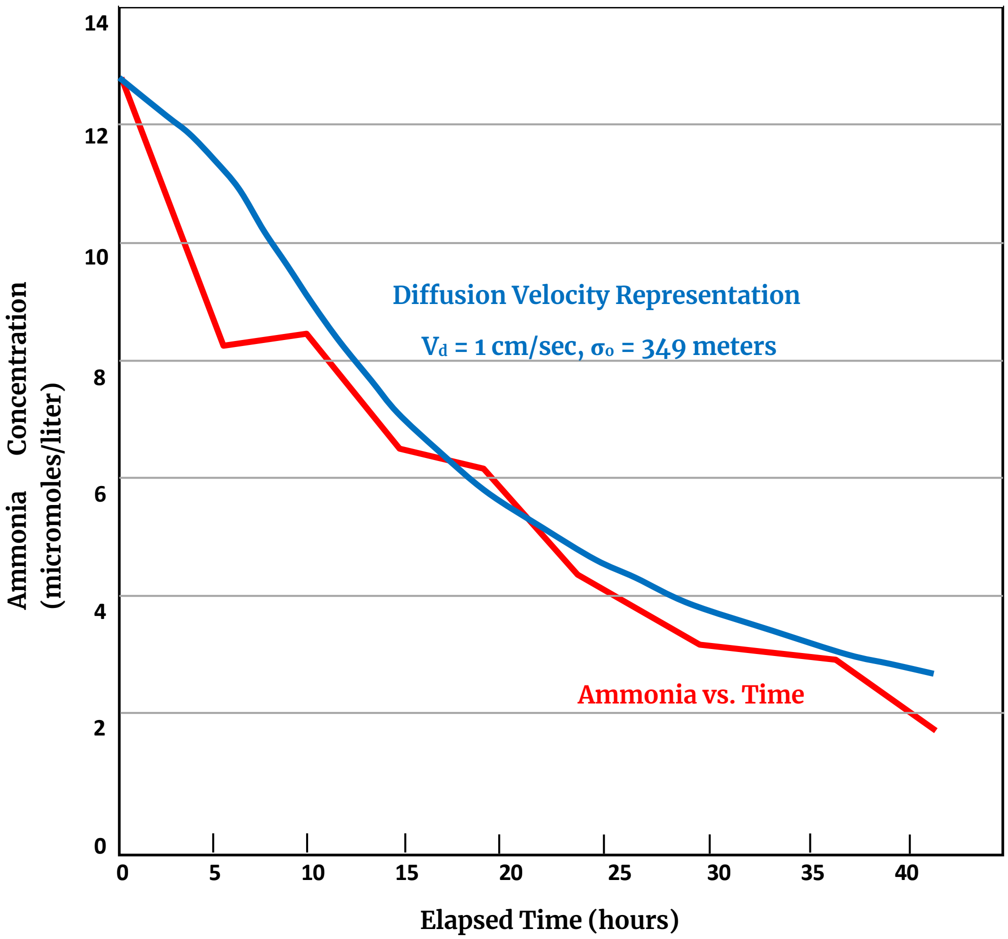


Figure R-1 presents the predicted rate of decrease in the peak concentration of ammonia in the wastefield based on a diffusion velocity of 1 cm/sec (0.01 meters per second (m/sec)). The predicted decrease in peak ammonia concentration is a reasonable approximation to the observed decrease, indicating that a diffusion velocity representation with a diffusion velocity of 1 cm/sec is appropriate for describing the cross-wastefield dispersion in this area.

The 1994 ATSD recommends that: "if the applicant can show that the 4/3 law (or some other relationship) is applicable to the discharge site, then that relationship should be used." A diffusion velocity-based representation and diffusion velocity of 1 cm/sec was used to estimate the subsequent dilutions associated with oceanic mixing in the Point Loma area since:

- Coastal dispersion is frequently observed to result in a patch whose variance increases with the square of time (Okubo, 1970).

- Diffusion velocities at a variety of coastal locations have been observed to be on the order of 1 cm/sec (Okubo and Pritchard, 1969).
- The dispersion of ammonia in a subsurface wastefield in the Point Loma area is well represented by a diffusion velocity of 1 cm/sec.

The initial width of the wastefield from the present (extended) outfall will be larger than from the previous outfall, since the length of the diffuser has been increased from about 810 m to about 1525 m. The subsequent dilutions used in the farfield DO depression calculations are based on an initial standard deviation of 658 m (versus the 349 m standard deviation for the ammonia distribution in the study at the old outfall). This value was selected based on the greatest dimension of the zone of initial dilution (ZID) (approximately 1,720 m) as per the legend for Equation B-17 in Appendix B of the ATSD. To this was added the effects of the spreading as the initial "top-hat" profile is transformed into a normal distribution.

Table R-5 presents subsequent dilutions through 96 hours of elapsed time, based on an initial standard deviation of 658 m. For comparison, Table R-5 also presents EPA-computed subsequent dilution estimates for 5,000 foot-wide (1,424 m) wastefield that are based on the following two methods:

- Case 1 - diffusivity (K_H) is a constant
- Case 2 - the "4/3's Law" (e.g., diffusivity is a function of distance to the 4/3 power)

Table R-5:
Subsequent Dilution for a Diffusion Velocity of 1 cm/sec

Elapsed Time (hrs)	Subsequent Dilution Ratio [A]		
	Computed Subsequent Dilution [A] (D)	EPA Value for Constant Diffusivity [B] K_H	EPA Value for 4/3's Law [C]
0	1.00 : 1	1.0 : 1	1.0 : 1
4	1.02 : 1	1.1 : 1	1.2 : 1
12	1.20 : 1	1.6 : 1	2.3 : 1
18	1.40 : 1	-	-
24	1.65 : 1	2.1 : 1	4.4 : 1
30	1.92 : 1	-	-
36	2.21 : 1	-	-
42	2.51 : 1	-	-
48	2.81 : 1	2.8 : 1	10.0 : 1
72	4.06 : 1	3.4 : 1	17.0 : 1
96	5.35 : 1	3.9 : 1	24.0 : 1

Table R-5 Notes:

A Subsequent dilutions after elapsed time of 96 hours. Based on initial standard deviation of 658 m, selected on the basis of the greatest dimension of the ZID (approximately 1,720 m) as per the legend for Equation B-17 in Appendix B of the ATSD.

B EPA-computed subsequent dilution values for a constant diffusivity, computed per Table B-5 of Appendix B of the ATSD.

C EPA-computed subsequent dilution values where diffusivity varies to the 4/3's power with distance. Values from Table B-5, Appendix B of the ATSD. (EPA 1994)

R.4.4 Results

Table R-6 presents computed farfield DO depressions using the data set presented in Table R-3. Within Table R-6, farfield $\Delta DO(\%)$ is computed to include DO depression from the effluent DO, the IDOD, the NBOD, and the CBOD. The calculations are based on the following:

$$\Delta DO(\%) = 100 \cdot \frac{\Delta DO}{DO_f} \qquad \textit{Equation } R-15$$

Where: ΔDO = the farfield DO depression

DO_f = the minimum level of DO in the wastefield as the result of the DO and IDOD in the effluent, DO uptake by the BOD exertion, and subsequent oceanic mixing with the surrounding higher DO water

Input values from May 23, 1990 result in the highest farfield DO drawdown (2.8%) for a PLOO flow of 240 mgd. Maximum computed DO drawdown during the critical February conditions was 2.4%.

Table R-6:
Farfield DO Depression Due to Discharged Wastewater
240 mgd PLOO Discharge

Date		Initial Dilution (S_a)	DO (mg/L)		Farfield ΔDO (%)	Elapsed Time to ΔDO (hrs)	Subsequent Dilution [A]
			DO_t	ΔDO			
1990	Mar. 7	287 : 1	5.37	0.10	1.9	34.5	2.14
	Apr. 17	253 : 1	4.78	0.11	2.4	35.5	2.18
	May 23	230 : 1	4.47	0.13	2.8	35.5	2.18
	Jun. 20	355 : 1	5.60	0.08	1.5	34.5	2.14
	Jul. 25	238 : 1	5.20	0.12	2.4	35.0	2.16
	Aug. 29	416 : 1	6.08	0.07	1.2	34.0	2.11
	Sept. 27	409 : 1	4.68	0.07	1.5	35.5	2.18
1991	Jan. 26	275 : 1	7.15	0.11	1.5	32.0	2.02
	Feb. 7	212 : 1	5.83	0.14	2.4	34.0	2.11
	Mar. 7	260 : 1	5.00	0.11	2.2	35.0	2.16
	Apr. 7	258 : 1	5.18	0.11	2.2	35.0	2.16

Table R-6 Notes:
A Values at time of maximum DO depression computed using Equation R-15 and input data form Table R-3.

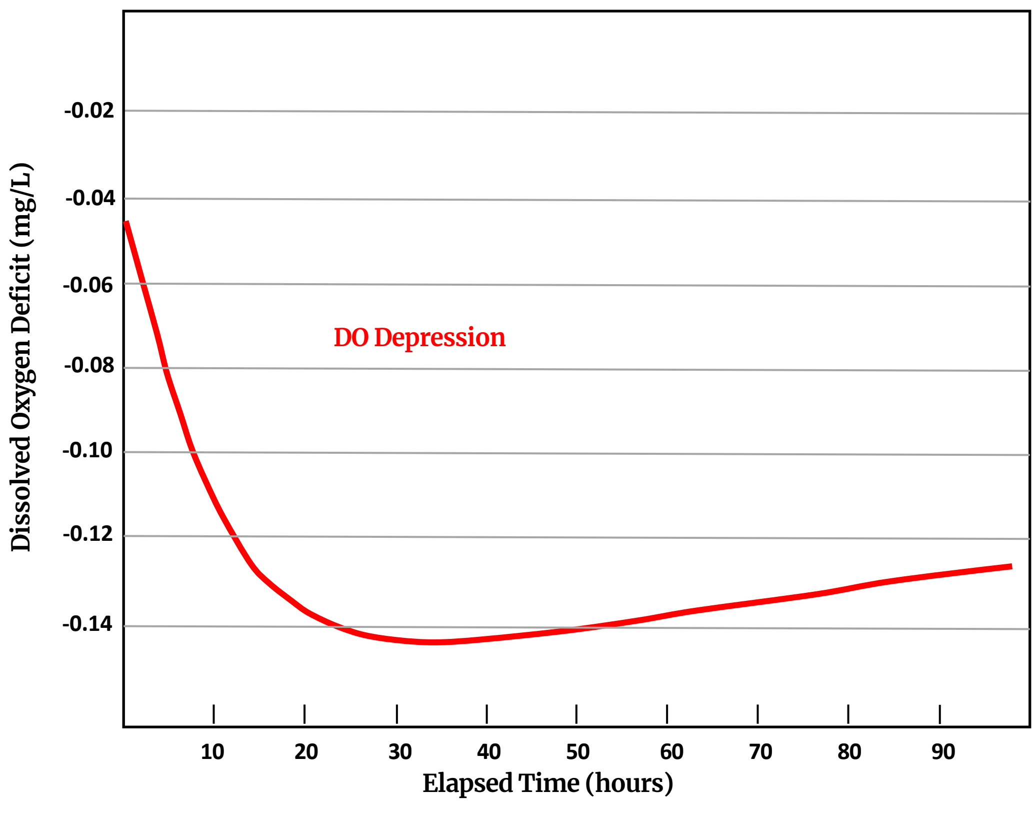
Figure R-2 illustrates the predicted depression curve of the DO concentration in the wastefield (with peak DO depression of 2.4%) during the critical February conditions. As shown in Figure R-2, the maximum reduction associated with the combination of effluent IDOD and BOD occurs approximately 34 hours after the wastewater release.

R.4.5 Alternative Approach

In order to demonstrate that there is always enough initial dilution, minimum dilutions required to comply with the Ocean Plan water quality objectives for DO are computed. To find the minimum allowable initial dilution for each month, a hypothetical case assuming a peak DO depression of 10% was used in conjunction with the historical low reading of DO in the ambient water at the wastefield depth.

Table R-7 summarizes the lowest allowable initial dilutions for each of the input data points (e.g., January, February, etc.) that could cause receiving water DO concentrations to be depressed by 10% at a PLOO flow of 240 mgd. Actual minimum PLOO initial dilutions are significantly in excess of these computed "threshold" dilutions required to cause a 10% DO reduction.

Figure R-2:
Computed DO Depression vs. Time
Critical DO Depression Conditions



Note: Critical conditions shown in Figure R-2 are based on conditions observed on February 7, 1991 superimposed on a 240 mgd PLOO discharge flow.

Table R-7:
Initial Dilutions Required to Cause DO Levels to be Depressed by 10% [A]

Parameter	Jan	Feb	Mar	April	May	June	July	Aug	Sept
DO at Wastefield Depth (DO_t)	3.80	3.60	3.50	2.82	3.25	2.99	3.88	2.66	3.98
Initial Dilution (S_a) Required to Cause 10% Depression of DO	76:1	80:1	82:1	100:1	88:1	95:1	74:1	106:1	72:1

Table R-7 Notes:

A Calculations based on a hypothetical 10% depression of DO_t.

R.5 CONCLUSIONS

The regulatory initial dilution values attainable by the PLOO discharge are presented in Table R-4. These values are in excess of the minimum dilutions allowable in Table R-7. This demonstrates that the PLOO is well within the Ocean Plan maximum DO depression limit of 10%. Moreover, these projected depressions are based on the following compounding conservative assumptions:

- the lowest historical DO concentrations.
- the nitrogen-BOD/total BOD ratio used in the calculation is at the lower limit of its range. (The average and median ratios were substantially larger than used in the simulations: approximately 12% versus 2.2%.)
- a DO of 0.0 mg/L was assumed for the effluent in lieu of the higher values typical in the PLOO effluent.
- an IDOD value of 4 mg/L was conservatively used based on EPA suggested values, in lieu of actual measured PLWTP IDOD values which ranged from 0.45 to 1.74 mg/L.
- maximum ambient water temperatures were used in computing decay rates (assuming the higher temperatures increase the decay rate and hence the DO reduction).

It is unlikely that some of these conservative conditions will ever occur, and the probability is infinitesimal that all of the assumed "worst case" conditions would occur at the same time. Because the initial dilution levels achieved by this outfall significantly exceed the values shown in Table R-7, farfield DO depressions that could result from the PLOO discharge will comply with Ocean Plan DO water quality objectives at all times with a substantial margin of safety throughout all ranges of anticipated PLWTP effluent BOD_5 concentrations.

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APPENDIX S

ANALYSIS OF AMMONIA

City of San Diego
Public Utilities Department

March 2022

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Acronyms and Abbreviations

°C	degrees Celsius
City	City of San Diego
EPA	United States Environmental Protection Agency
lbs/day	pounds per day
MER	mass emission rate
mg/L	milligrams per liter
mgd	million gallons per day
mt/year	metric tons per year
NH_3	un-ionized ammonia
NH_4^+	ammonium ion
NO_2	nitrite
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan, Ocean Waters of California
pK_a	acid disassociation constant
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
ppt	parts per thousand
RWQCB	Regional Water Quality Control Board, San Diego Region
SWRCB	State Water Resources Control Board
WQBEL	Water Quality-Based Effluent Limitation
ZID	zone of initial dilution

S.1 BACKGROUND

This appendix presents an analysis of ammonia discharged from the Point Loma Wastewater Treatment Plant (PLWTP) and demonstrates that the Point Loma Ocean Outfall (PLOO) discharge complies with applicable State of California receiving water quality objectives for ammonia. The PLOO discharge also complies with applicable federal water quality criteria for ammonia in marine waters. To assess ammonia compliance under current discharge conditions, this appendix evaluates PLWTP effluent data from 2017-2020 using the approach presented in the City of San Diego's (City's) original 1995 301(h) application.

This appendix estimates maximum receiving water ammonia-nitrogen concentrations that may result from the discharge of treated wastewater from the PLWTP to the ocean via the PLOO. Receiving water ammonia concentrations are computed on the basis of PLWTP effluent ammonia concentrations for the period 2017-2020 and initial dilution rates assigned in San Diego Regional Water Quality Control Board (RWQCB) and United States Environmental Protection Agency (EPA) Order No. R9-2017-0007 (National Pollutant Discharge Elimination System (NPDES) CA0107409).

A maximum day receiving water ammonia concentration of 0.24 milligrams per liter (mg/L) is projected upon completion of initial dilution. A maximum 6-month median receiving water ammonia-nitrogen concentration of 0.13 mg/L is projected.[1] These projected receiving water concentrations are significantly below receiving water quality objectives for ocean waters that are established by the State Water Resources Control Board (SWRCB) in the *Water Quality Control Plan, Ocean Waters of California* (Ocean Plan).[2] The concentrations are also significantly below federal water quality criteria for ammonia-nitrogen in saltwater. Further, the PLOO mass emissions of ammonia-nitrogen are less than water quality-based mass emission performance goals established by the RWQCB and EPA within Table 6 of Order No. R9-2017-0007.

S.2 INTRODUCTION

Ammonia is a common constituent of wastewater formed by the biological degradation of proteins and urea. Ammonia can also be contributed by industry through the use of ammonia as a means of neutralizing low pH industrial discharges.

Ammonia typically occurs at concentrations on the order of 25 to 50 mg/L (as total ammonia-nitrogen, including both NH_4^+-N and NH^3-N) within primary treated effluent and un-nitrified secondary effluent. Secondary treatment employing a nitrification process can reduce effluent ammonia concentrations from these levels by converting ammonia to nitrite (NO_2) and nitrate (NO_3), but total nitrogen concentrations are not significantly reduced by secondary treatment unless a more complex denitrification/nitrification secondary treatment process is implemented to convert nitrite and nitrate to nitrogen gas.

1 Projected ammonia-nitrogen concentrations after initial dilution are computed (see Case 1 in Table S-7) on the basis of no detectable ammonia in the ambient receiving water. Table S-7 also presents projected receiving water concentrations upon initial dilution under Case 2 conditions where ambient receiving water ammonia concentrations are 0.1 mg/L.

2 The current version of the Ocean Plan was adopted by the SWRCB on August 7, 2018 and became effective on February 4, 2019.

Ambient or background levels of ammonia in seawater in Southern California have been shown to range from zero to 0.014 mg/L as ammonium (NH_4^+).[3] Ammonia is an essential macronutrient, but in higher concentrations, ammonia can be toxic. Ammonia is readily nitrified in oxygenated waters, and is not bioaccumulated, bioconcentrated, or biomagnified.

3.3 AMMONIA SPECIATION

The speciation of total ammonia between its ionized (NH_4^+) and un-ionized (NH_3) forms is a major factor affecting the potential effects of ammonia on the marine environment. The term ionized ammonia is used herein to describe the compound NH_4^+, and the term un-ionized ammonia is used to describe NH_3. Ammonia is considerably more toxic to aquatic organisms in its un-ionized (NH_3) form; since the NH_3 molecule is lipid soluble and uncharged, it rapidly permeates cell membranes, particularly the gills of fish. Equilibrium between ionized and un-ionized ammonia is expressed as:

$$NH_4^+ \leftrightarrow NH_3 + H^+ \qquad Equation\ S-1$$

The effects of pH, temperature, and salinity (ionic strength) on this relationship are well studied and documented within standard chemistry and solubility textbooks. At a given ammonia concentration, the un-ionized concentration or percentage that has dissociated will decrease with decreasing pH, decreasing temperature and increasing salinity.

Numerous researchers have addressed ammonia equilibrium and solubility relations in seawater. Research addressing salinity, pH, and temperature effects on ammonia equilibrium in seawater has, in part, included:

1. Whitfield (1974) reported on a precise and detailed evaluation of the effects of pH, temperature, and salinity on the speciation of ammonia.
2. Bower and Bidwell (1978) tabulated the ammonium dissociation constant (pK_a) versus temperature and pH for various salinities on the basis of Whitfield's results.
3. Johannson and Wedborg (1979) assessed the ammonium dissociation constant (pK_a) versus pH for a range of seawater concentrations.
4. Skarheim (1973) tabulated values for the un-ionized fraction of total ammonia under equilibrium conditions corresponding to a range of environmental circumstances.

Clegg and Whitfield (1995) developed a model for determining the ammonia acid dissociation constant (pK_a) in marine waters as a function of temperature and ionic strength. Based on this work, Bell et al. (2007) presented the following simplified formula for estimating the ammonia acid dissociation constant on the basis of receiving water temperature (t, measured in degrees Celsius (°C)) and salinity (S, measured in parts per thousand (ppt)):

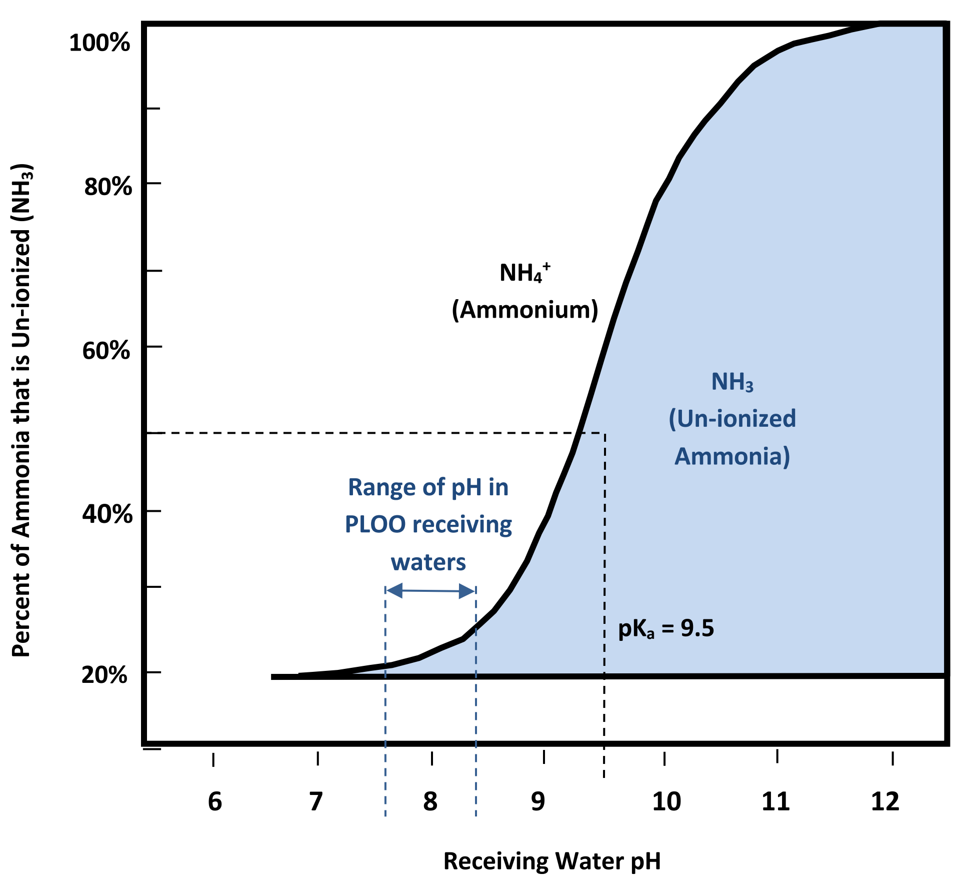
$$pK_a = 10.0423 - (0.0315536 \cdot t) + (0.003701 \cdot S) \qquad Equation\ S-2$$

3 Reference: Eppley, et al. (1979)

City of San Diego receiving water monitoring conducted during the effective period of Order No. R9-2017-0007 document that PLOO receiving water temperatures ranged from approximately 10 °C to 22 °C and salinity values ranged from 33 to 34 ppt.[4] Based on the equation of Bell et al. (2007), the corresponding pK_a value for ammonia is approximately 9.5 at a temperature of 10 °C, while the pK_a value would be 9.8 at a 22 °C temperature.

Figure S-1 schematically presents the breakdown of speciation between the ammonium ion (NH_4^+) and un-ionized ammonia (NH_3) for a pK_a of 9.5. As shown in Figure S-1, over the range of values of pH, temperature, and salinity normally encountered in PLOO receiving waters, the ammonium ion (NH_4^+) is the dominant ammonia species present. Although un-ionized ammonia is favored by high pH, high temperature, and low ionic strength, the dominance of NH_4^+ is a virtual certainty in well buffered, constant salinity system (such as open seawater) in which wastewater constituents are rapidly dispersed. Un-ionized ammonia (see Figure S-1) would typically constitute between 2% and 7% of the total ammonia in such a receiving water environment.

Figure S-1: Ammonium/Ammonia Speciation as a Function of pH



4 Reference: City of San Diego (2021a, 2021b).

S.4 WATER QUALITY CRITERIA AND STANDARDS

S.4.1 EPA Water Quality Criteria for Ammonia

EPA establishes federal water quality criteria as guidance to states for establishing water quality standards for the protection of aquatic habitat and human health.

Recognizing the pH-dependent, salinity-dependent and temperature-dependent effects on ammonia speciation, EPA ammonia criteria for saltwater are established in terms of receiving water pH, salinity and temperature.[5]

Table S-1 summarizes the range of pH and temperature in PLOO receiving waters. As shown in the table, pH values typically range from 7.7 to 8.2 pH units at subsurface depths. Receiving water temperature varies with season, but subsurface waters are almost always within the range of 10 °C to 15 °C, with a short-term maximum observed value of 18 °C.

Table S-1:
Range of Temperature and pH in the PLOO Discharge Zone, 2017 – 2020[A]

Receiving Water Depth	pH [B] (pH Units)		Temperature [B] (°C)	
	Low Value	High Value	Low Value	High Value
Surface Waters [C]	7.8	8.4	10	26
Subsurface [D]	7.7	8.2	9.5	24

Table S-1 Notes:
- A Data from City of San Diego annual receiving water monitoring conducted under Order No. R9-2017-0007 (City of San Diego, 2021a, 2021b).
- B Observed low and high values rounded to two significant figures.
- C Includes data from depths of less than 20 meters.
- D Includes data from depths of more than 20 meters.

Table S-2 presents pH-dependent and temperature-dependent EPA water quality criteria for ammonia in salt water for the range of pH and temperature expected in the PLOO discharge zone. As shown in Table S-2, the most stringent ammonia criteria occur for higher salinities and temperatures.

Based on observed receiving water quality during 2017-2020, the most critical 30-day average receiving water conditions that would be expected at depth near the PLOO zone of initial dilution (ZID) boundary would be pH of approximately 8.2 and a temperature of approximately 15 °C. The EPA 30-day average ammonia concentration criterion (see Table S-2) for these conditions is 1.0 mg/L.

5 Reference: EPA (1989).

S.4.2 Ocean Plan Ammonia Water Quality Objectives

Ammonia discharges in California are regulated under provisions of the Ocean Plan, which was most recently updated by the SWRCB in 2019. Ocean Plan water quality objectives for ammonia are presented in Table S-3.

Table S-2:
EPA Ambient Saltwater Criteria for Ammonia-Nitrogen
(Criteria for Salinity of 30 grams of salt per kilogram of water)

Period	pH	Ammonia Concentration Criteria [A,B] (mg/L NH_3-N)			
		10° C	15° C	20° C	25° C
Criteria Maximum Concentration [C]	7.6	37	25	21	12
	7.8	23	16	11	7.9
	8.0	15	10	7.3	5.0
	8.2	9.6	6.7	4.6	3.3
	8.4	6.0	4.2	2.9	2.1
Criteria Continuous Concentration [D]	7.6	5.6	3.7	3.1	1.7
	7.8	3.4	2.4	1.7	1.0
	8.0	2.2	1.6	1.1	0.66
	8.2	1.4	1.0	0.69	0.44

Table S-2 Notes:

A From EPA (1989). Criteria are listed for the range of pH and temperatures common to the PLOO outfall waste field. Ammonia criteria become more relaxed with increasing salinity. The typical ocean salinity near San Diego is approximately 33 to 34 g/kg, so the above values based on a 30 g/kg salinity are conservative.

B The above water quality criteria are not enforceable standards but are presented by EPA as guidance to States and Tribes in developing enforceable water quality standards.

C The criteria maximum concentration is the maximum concentration to which an aquatic community can be briefly exposed without what EPA terms "unacceptable effect". National water quality criteria issued by EPA do not define what constitutes an "unacceptable effect", but EPA-published guidance (EPA, 2010) indicates that any statistically significant decrease in taxa or populations of organisms should "usually" be considered unacceptable.

D The criteria continuous concentration is the maximum concentration that an aquatic community can be continuously and indefinitely exposed to without what EPA terms as "unacceptable effect".

Table S-3:
Ocean Plan Water Quality Objectives for Ammonia-Nitrogen

Period	Ocean Plan Concentration Standard for Total Ammonia-Nitrogen in Receiving Waters[A]
6-Month Average	0.6 mg/L
Daily Maximum	2.4 mg/L
Instantaneous Maximum	6.0 mg/L

Table S-3 Notes:

A Ocean Plan Receiving water quality objective to be achieved upon completion of initial dilution.

S.4.3 Ammonia Performance Goals Established in Order No. R9-2017-0007

Table S-4 presents ammonia performance goals established in Order No. R9-2017-0007. Order No. R9-2017-0007 implements Ocean Plan water quality objectives by establishing performance goals (also known as benchmarks).[6] Two types of performance goals are established within Order No. R9-2017-0007. One set of performance goals (established in Table 6 of Order No. R9-2017-0007) implements the Ocean Plan receiving water objectives to protect beneficial uses. The second set (established in Table 7 of Order No. R9-2017-0007 establishes a benchmark which (if exceeded) may indicate the need for an assessment of compliance with federal antidegradation regulations.[7]

6 Performance goals established in Table 7 of Order No. R9-2017-007 for parameters that the RWQCB and EPA determine do not have a reasonable potential to cause or contribute to an exceedance of a water quality objective, or for which reasonable potential to cause or contribute to an exceedance of water quality objectives cannot be determined. Performance goals are not water quality-based effluent limitations (WQBELs) and are not enforceable as such.

7 Federal antidegradation regulations are established in Title 40, Section 131 of the *Code of Federal Regulations* (40 CFR 131), and require that the level of water quality necessary to protect beneficial uses shall be maintained (Tier 1) and that, where water quality is better than necessary to support beneficial uses, the level of water quality is to be maintained and protected unless the permitting authority finds that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located; existing uses are fully protected; the highest statutory and regulatory requirements are achieved for all new and existing point sources; and all cost-effective and reasonable best management practices for nonpoint source control are implemented (Tier 2).

Table S-4:
Ammonia Performance Goals Established in Order No. R9-2017-0007

Period	Units	Ammonia (as Nitrogen) Performance Goal			
		6-Month Median	Daily Maximum	Instantaneous Maximum	Annual Mass Emission
Performance Goals to Implement Ocean Plan Water Quality Objectives [A]	mg/L	120	490	1,200	NA [B]
	lbs/day [C]	210,000	840,000	2,100,000	NA [B]
	mt/year [D]	35,000	139,000	349,000	NA [B]
Performance Goals to Address Antidegradation Considerations [E]	mt/year	NA [B]	NA [B]	NA [B]	8,018

Table S-4 Notes:

A Performance goal established within Table 6 of Order No. R9-2017-0007 to implement the Ocean Plan receiving water concentration objectives of 0.6 mg/L (6-month average), 2.4 mg/L (daily maximum) and 6.0 mg/L (instantaneous maximum). The Ocean Plan receiving water quality objectives are to be achieved upon completion of initial dilution. See Table S-3. Order No. R9-2017-0007 establishes effluent performance goals for ammonia-nitrogen on the basis of an assigned PLOO minimum month initial dilution of 204:1.

B NA indicates that no performance goal is established within the listed category.

C Mass emission performance goal in units of pounds per day (lbs/day).

D For comparison purposes, the mass emission Table 6 performance goal of Order No. R9-2017-0007 that is expressed in terms of pounds per day is converted to units of metric tons per year (mt/year). Values rounded to nearest 1000 mt/year.

E The mass emission performance goal established by EPA in Table 7 of Order No. R9-2017-0007 was established on the basis of the n-day average monthly performance (95th percentile) of the PLWTP during 1990-1995. The 8,018 mt/year ammonia benchmark was implemented to establish a framework for evaluating the need for antidegradation analysis. Under this framework, PLWTP mass emission rates (MERs) that exceed the EPA mass emission benchmarks may trigger the need for an antidegradation analysis to demonstrate compliance with EPA Tier I and (if applicable) Tier II antidegradation regulations. The mass emission performance goals are not WQBELs and are not enforceable as such.

S.5 COMPLIANCE WITH CRITERIA AND STANDARDS

S.5.1 PLOO Effluent Quality

Table S-5 summarizes monthly average total ammonia-nitrogen concentrations in the PLWTP effluent during 2017-2020. PLWTP effluent ammonia-nitrogen concentrations averaged 41.8 mg/L during 2017-2020. As shown in Table S-5, PLWTP effluent ammonia-nitrogen concentrations were slightly higher in summer months than winter months during this period.

Table S-5:
PLWTP Effluent Ammonia-Nitrogen Concentrations, Breakdown by Month 2017-2020

Period	PLWTP Average Monthly Effluent Ammonia-Nitrogen Concentration [A] (mg/L as N)				
	2017	2018	2019	2020	2017-2020
January	34.2	41.9	38.7	39.5	38.6
February	36.2	43.9	38.3	43.0	40.3
March	36.5	43.4	40.1	39.5	39.9
April	42.3	43.8	42.6	40.3	42.2
May	41.2	42.7	43.0	44.8	42.9
June	42.6	43.4	43.8	43.4	43.3
July	42.1	43.9	43.7	43.3	43.3
August	40.9	42.1	45.8	41.6	42.6
September	41.0	43.0	44.0	45.0	43.2
October	42.6	43.2	44.5	40.3	42.6
November	41.8	43.2	43.5	38.9	41.8
December	41.5	41.2	37.0	40.7	40.1
Annual Average [B]	40.2	43.0	42.1	41.7	41.8
Maximum Month [C]	42.6	43.9	45.8	45.0	45.8

Table S-5 Notes:

A Monthly averages are based on weekly ammonia monitoring data from annual and monthly monitoring reports submitted by the City to the RWQCB during 2017-2020. (City of San Diego, 2017-2020) Calendar year 2020 is the most recent year for which a complete 12-month data set was available at the time of preparation of this report. Data for calendar year 2021 will be electronically transmitted to regulators under separate cover at a later date.

B Computed as the arithmetic average of all daily ammonia-nitrogen samples collected during the listed year.

C Maximum monthly average ammonia-nitrogen concentration observed during the listed year, as reported in annual PLWTP reports.

Table S-6 presents a statistical breakdown of PLWTP ammonia-nitrogen concentrations during 2017-2020. The median PLWTP ammonia-nitrogen concentration during 2017-2020 was 42.2 mg/L, and daily values ranged from a maximum of 48.1 mg/L (March 14, 2018) to a minimum of 24.4 (January 23, 2017). All PLWTP effluent ammonia samples during 2017-2020 were more than an order of magnitude (10^1) less than the 490 mg/L daily maximum performance goal established in Order No. R9-2017-0007. The maximum observed 6-month median ammonia concentration during 2017-2020 was 44.3 mg/L - a value well within the 120 mg/L 6-month median performance goal established within Order No. R9-2017-0007.

Table S-6:
Statistical Breakdown of PLWTP Effluent Ammonia-Nitrogen Concentrations, 2017-2020

Period	PLWTP Effluent Ammonia-Nitrogen Concentration [A] (mg/L as N)				
	2017	2018	2019	2020	2017-2020
Maximum Daily Value [B]	44.5	48.1 [C]	46.4	46.9	48.1 [C]
90^{th} Percentile Daily Value	43.1	44.6	45.7	45.4	44.9
75^{th} Percentile Daily Value	42.2	43.8	44.2	43.7	43.7
50^{th} Percentile Daily Value	41.5	43.1	43.0	42.0	42.2
25^{th} Percentile Daily Value	39.3	42.1	40.0	39.9	40.5
10^{th} Percentile Daily Value	37.0	41.3	38.0	37.7	38.1
Minimum Daily Value [D]	24.4 [E]	39.6	33.6	36.5	24.4 [E]
Maximum 6-Month Median Value [F]	42.1	43.7	44.1	43.9	44.1
Number of Sample Dates during Year	48	48	47	53	196

Table S-6 Notes:

A Based on weekly ammonia monitoring data from annual and monthly monitoring reports submitted by the City to the RWQCB during 2017-2020. (City of San Diego, 2017-2020) Calendar year 2020 is the most recent year for which a complete 12-month data set was available at the time of preparation of this report. Data for calendar year 2021 will be electronically transmitted to regulators under separate cover at a later date.

B Maximum daily value observed during the listed year.

C Maximum daily ammonia-nitrogen concentration of 48.1 mg/L occurred on March 14, 2018.

D Minimum daily value observed during the listed year.

E Minimum value occurred on January 23, 2017. All other PLWTP daily effluent ammonia values were greater than 30 mg/L

F Maximum 6-month median value observed during the listed data period.

S.5.2 Projected Receiving Water Quality

The effluent total ammonia-nitrogen concentrations presented in Tables S-5 and Table S-6 can be combined with projected initial dilutions from the PLOO to estimate receiving water ammonia-nitrogen concentrations at the edge of the ZID upon completion of initial dilution.

Order No. R9-2017-0007 assigns a minimum month average initial dilution of 204:1 for purposes of assessing compliance with Ocean Plan receiving water quality objectives. As documented in Appendix Q, however, the PLOO is projected to typically achieve initial dilutions in excess of this 204:1 value. Table S-7 presents estimated receiving water ammonia-nitrogen concentrations at the ZID boundary under the 204:1 minimum average month initial dilution assigned in Order No. R9-2017-0007, and the long-term median PLOO initial dilution of 338:1 computed within Appendix Q.

**Table S-7:
Projected Ammonia-Nitrogen Receiving Water Concentrations
Upon Completion of Initial Dilution**

Parameter	Units	Case 1: Ambient Seawater Total Ammonia Concentration of Zero [A]		Case 2: Ambient Seawater Total Ammonia Concentration of 0.014 mg/L [B]	
		Maximum Day [C]	Maximum 6-Month Median [D]	Maximum Day [C]	Maximum 6-Month Median [D]
Point Loma Effluent Ammonia-Nitrogen Concentration [E]	mg/L (as N)	48.1	44.1	48.1	44.1
Initial Dilution	-	204:1 [F]	338:1 [G]	204:1 [F]	338:1 [G]
Projected Receiving Water Ammonia-Nitrogen Concentration [H]	mg/L (as N)	0.23 [I]	0.13 [J]	0.25 [I]	0.14 [J]
Ocean Plan Ammonia-Nitrogen Water Quality Objective [K]	mg/L (as N)	2.4	0.6	2.4	0.6

Table S-7 Notes:

A Ammonia in seawater is predominantly in the form of ammonium (NH_4^+). As documented by Eppley (1979), ambient or background levels of ammonia in seawater in Southern California have been shown to range from zero to 0.014 mg/L. Case 1 assesses projected receiving water concentrations after initial dilution at the lower end of this range where ambient receiving water is assigned a total ammonia (NH_3 + NH_4^+) concentration of zero.

B Order No., R9-2017-0007 does not require collection of receiving water data for ammonia or nutrients and no ammonia receiving water data are available for the PLOO outfall area. For demonstration purposes, Case 2 assesses projected receiving water concentrations after initial dilution where the ambient total ammonia concentration is 0.014 mg/L (the upper limit cited by Eppley, 1979).

C Maximum daily ammonia-nitrogen concentration during 2017-2020.

D Maximum 6-month median observed during the listed year. Based on computed 6-month running median, where the 6-month median concentration for any given sampling date is computed as the median concentration value of all prior PLOO ammonia samples collected during the preceding six-month period.

E Maximum day and maximum 6-month median PLWTP effluent ammonia concentration. Values from Table S-6.

F Minimum month initial dilution assigned in Order No. R9-2017-0007 for purposes of determining compliance with criteria for the protection of aquatic life.

G Median PLOO initial dilution. See Appendix Q.

H Projected receiving water concentration after initial dilution computed using Equation 1 of the 2019 Ocean Plan (SWRCB, 2019).

I Computed receiving water concentration at the edge of the ZID upon completion of initial dilution at an initial dilution of 204:1 and a maximum day effluent concentration of 48.1 mg/L.

J Computed receiving water concentration at the edge of the ZID upon completion of initial dilution at a median initial dilution of 338:1 and a maximum 6-month median ammonia concentration of 44.3 mg/L. Ocean Plan receiving water standard for the protection of aquatic habitat to be achieved upon completion of initial dilution.

S.5.3 Compliance with Ocean Plan Ammonia Water Quality Objectives

As shown in Table S-7, under both receiving water cases, the maximum day ammonia-nitrogen receiving water concentrations after completion of initial dilution are projected to be significantly below the Ocean Plan-based performance goal for ammonia that is established in Table 6 of Order No. R9-2017-0007.[8] Additionally, maximum 6-month median ammonia-nitrogen receiving water concentrations are projected to be significantly below the 6-month median performance goal for ammonia that is established in Table 6 of Order No. R9-2017-0007.[9]

It should be noted that the receiving water concentrations projected in Table S-7 would occur immediately at the edge of the ZID. Receiving water ammonia concentrations beyond the edge of the ZID would be further reduced after initial dilution as a result of:

- additional dilution and dispersion as the plume is advectively transported by currents
- oxidation (via nitrification) of ammonia to nitrite and/or nitrate
- biological assimilation by marine algae (phytoplankton) and marine organisms

S.5.4 Compliance with Federal Water Quality Criteria

As shown in Table S-2, federal water quality criteria for un-ionized ammonia-nitrogen are dependent on salinity, pH, and temperature. The maximum daily projected PLOO receiving water concentrations presented in Table S-7 are significantly below corresponding federal water quality criteria for all anticipated ranges of PLOO receiving water temperature and salinity.

PLOO receiving water data (see Table S-1) indicate that a receiving water pH of 8.2 and temperature of 15 °C represent "worst case" sustained conditions for un-ionized ammonia dissociation. Under such sustained pH and temperature conditions, the corresponding criteria continuous concentration limit (e.g., 30-day average criterion) for ammonia-nitrogen criterion is 1.0 mg/L. The projected PLOO maximum 6-month median values for Case 1 and Case 2 (see Table S-7) are significantly below this criterion.

S.6 AMMONIA MASS EMISSIONS

To implement Ocean Plan receiving water quality objectives to protect beneficial uses, Table 6 of Order No. R9-2017-0007 establishes mass emission performance goals of 210,000 lbs/day (6-month median) and 840,000 lb/day (daily maximum).[10]

Table S-8 presents a monthly breakdown of PLOO MERs for ammonia-nitrogen during 2017-

8 Table 6 of Order No. R9-2017-0007 establishes a daily maximum ammonia receiving water performance goal of 2.4 mg/L to implement Ocean Plan receiving water quality objectives to protect beneficial uses.

9 Table 6 of Order No. R9-2017-0007 establishes a 6-month median ammonia receiving water performance goal of 0.6 mg/L to implement Ocean Plan receiving water quality objectives to protect beneficial uses.

10 WQBELs are established in Table 6 of Order No. R9-2017-0007 to implement Ocean Plan water quality objectives for the protection of beneficial uses.

2020. Daily, monthly and annual MERs shown in Table S-8 were computed using PLWTP flows on each date on which an ammonia-nitrogen effluent sample was collected.

**Table S-8:
PLWTP Effluent Ammonia-Nitrogen Mass Emission Rates
Breakdown by Month, 2017-2020**

Period	PLWTP Average Monthly Effluent Ammonia-Nitrogen Mass Emission Rate [A] (lbs/day as N)				
	2017	2018	2019	2020	2017-2020 [B]
January	48,025	46,200	44,480	48,520	46,800
February	47,600	50,900	52,750	53,850	51,300
March	48,800	52,450	51,250	51,525	51,000
April	49,475	50,950	50,150	52,920	50,900
May	48,167	48,700	50,100	51,675	49,700
June	45,360	48,375	49,675	50,280	48,400
July	44,825	48,960	48,280	49,175	47,800
August	43,550	49,133	50,350	48,325	47,800
September	42,950	49,300	48,920	52,200	48,300
October	45,367	52,575	49,850	46,925	48,700
November	44,280	50,900	48,260	44,275	46,900
December	43,600	49,850	49,050	46,440	47,200
Annual Average [C]	45,900	49,800	49,100	49,700	48,600
Maximum Month [D]	49,475	52,575	52,750	53,850	53,850

Table S-8 Notes:

A Based on weekly ammonia monitoring data from annual and monthly monitoring reports submitted by the City to the RWQCB during 2017-2020. (City of San Diego, 2017-2020) MERs for each sample date were computed on the basis of daily ammonia concentrations and the PLWTP flow on that date. Listed monthly averages represent the average of all MER values computed during the month. Values may differ from monitoring reports submitted to the RWQCB where values were computed on the basis of average monthly flow and average monthly ammonia-nitrogen concentrations.

B Monthly average MER during the listed month within 2017-2020. Values rounded to three significant figures.

C Annual arithmetic average of MERs on all dates during the year where ammonia samples were collected. Values rounded to three significant figures.

D Maximum monthly average MER observed during the listed year, computed as the on the basis of the average of daily MERs for the listed month.

Table S-9 compares PLOO ammonia-nitrogen mass emission during 2017-2020 with Ocean Plan-based ammonia performance goal MERs established in Order No. R9-2017-0007. The Ocean Plan-based MER performance goals are established to prevent ammonia-related impacts to beneficial uses. As shown in Table S-9, PLOO ammonia MERs during 2017-2020 averaged 48,600 lbs/day. The PLOO discharge during 2017-2020 complied with the Ocean Plan-based daily maximum ammonia MER performance goal of Order No. R9-2017-0007 more than an order of magnitude. The PLOO discharge during 2017-2020 complied with the Ocean Plan-based six-month median ammonia MER by more than a factor of five.

**Table S-9:
PLOO Ammonia-Nitrogen Mass Emissions
Compliance with Ocean Plan-Based Mass Emission Performance Goals**

Year	PLOO Ammonia Mass Emissions [A] MERs in pounds per day (lbs/day)		
	Maximum Observed Daily Value [B]	Maximum Observed 6-Month Median Value [C]	Average Annual MER [D]
2017	51,800 [E]	48,600	46,000
2018	58,000 [F]	50,600	49,800
2019	54,600 [G]	51,100	49,100
2020	55,600 [H]	51,700	49,700
Mass Emission Performance Goal Established in Table 6 of Order No. R9-2017-0007 [I]	840,000	210,000	No Performance Goal

Table S-9 Notes:

A From PLWTP daily flow and ammonia concentration data submitted by the City to the RWQCB during 2017-2020. Calendar year 2020 is the most recent year for which a complete 12-month data set was available at the time of preparation of this report. Data for calendar year 2021 will be electronically transmitted to regulators at a later date.

B Maximum daily MER observed during the listed year. Daily ammonia MERs (rounded to three significant figures) are computed on the basis of the observed PLWTP ammonia concentration and the PLWTP flow on that sampling date. See Attachment 1 to the Antidegradation Analysis (Volume II) for daily data.

C Maximum 6-month median value based on daily running totals for each sample date using data from the prior 6-months. See Attachment 1 to the Antidegradation Analysis (Volume II) for daily data. Maximum 6-month median values computed using daily data may differ from maximum 6-month median values computed on the basis of monthly averages.

D Average Annual MER for the listed year, based on the average of available daily MER values during the year. See Attachment 1 to the Antidegradation Analysis (Volume II) for daily data.

E Maximum daily 2017 MER occurred on March 6, 2017, with a PLWTP flow of 173.1 million gallons per day (mgd) and an ammonia-nitrogen effluent concentration of 35.9 mg/L.

F Maximum daily 2018 MER occurred on March 14, 2018, with a PLWTP flow of 144.7 mgd and an ammonia-nitrogen effluent concentration of 48.1 mg/L.

G Maximum daily 2019 MER occurred on February 25, 2019, with a PLWTP flow of 172.8 mgd and an ammonia-nitrogen effluent concentration of 37.9 mg/L.

H Maximum daily 2020 MER occurred on February 29, 2020, with a PLWTP flow of 142.6 mgd and an ammonia-nitrogen effluent concentration of 46.9 mg/L.

I Table 6 of Order No. R9-2017-0007 establishes non-enforceable MER performance goals for ammonia-nitrogen that implement Ocean Plan receiving water quality objectives for the protection of beneficial uses.

Table 7 of Order No. R9-2017-0007 establishes EPA toxics mass emission performance goals for the PLOO discharge. The ammonia performance goal within Table 7 of Order No. R9-2017-0007 is not based on any water quality-related standard but was established by EPA as a framework for evaluating the need for antidegradation analysis at the time of permit reissuance. The Table 7 ammonia mass emission benchmark of 8,018 mt/year was established by EPA on the basis of PLWTP ammonia mass emissions during 1990-1995.[11]

Table S-10 compares the Table 7 EPA ammonia benchmark with annual ammonia mass emissions during 2017-2020. MERs are computed using the following two methods:

- multiplying the annual average flow by the average annual ammonia concentration and converting to metric tons per year
- the cumulative total of daily mass emissions during the year

As shown in Table S-10, ammonia MERS emissions during 2018, 2019 and 2020 are slightly higher than the 95th percentile PLOO mass emissions from 1990-1995 (on which the Table 7 MER performance goal benchmark is based). For this reason, this NPDES application package addresses how the increase in PLOO ammonia mass emissions compared to 1990-1995 is consistent with federal antidegradation regulations and the State of California antidegradation policy. As documented in Volume II of this NPDES application, the PLOO discharge complies with Tier 1 and Tier 2 antidegradation regulations, as:

- the PLOO discharge meets all applicable water quality standards for ammonia-nitrogen and nitrogen compounds
- water quality necessary to support beneficial uses is maintained
- the increase in ammonia mass emissions since 1990 is deemed to be "not significant" as receiving water quality beyond the ZID is less than considerably less than 50% of the Ocean Plan receiving water standard
- historical receiving water monitoring conducted by the City has shown that receiving water concentrations of ammonia in the PLOO area are non-detectable or extremely low[12]

11 The 8,018 mt/year ammonia benchmark established within Table 7 of Order No. R9-2017-0007 is based on the PLWTP permitted flow of 205 mgd and the n-day average monthly performance (95th percentile) PLWTP ammonia MER during 1990-1995. This 8,018 mt/year ammonia benchmark was implemented to establish a framework for evaluating the need for antidegradation analysis. Exceedance of this metric is indicative that PLOO ammonia MER levels have increased beyond those of 1990-1995 and that additional analysis may be required to demonstrate compliance with Tier I antidegradation regulations.

12 Order No. R9-2009-0001 (the prior PLOO NPDES permit) required the collection of receiving water data for ammonia. As discussed on page F-15 of Attachment F to Order No. R9-2017-0007, receiving water monitoring for ammonia "has produced no useful data since all ammonia results have been very low or ND near the outfall." As a result of this, receiving water monitoring for ammonia was removed within Order No. R9-2017-0007.

Table S-10:
PLOO Compliance with EPA Ammonia MER Benchmark for Evaluating the Need for Antidegradation Analysis

Year	Average Annual PLWTP Flow (mgd)	Average Annual PLWTP Ammonia-Nitrogen Concentration [A] (mg/L)	Annual PLOO Ammonia Mass Emissions [B] (mt/year)	
			Computed Using Average Annual Flow and Annual Average Ammonia Concentration [C]	Computed as Cumulative Total of Daily Mass Emissions During the Year [D]
2017	139.3	40.2	7,610	7,750
2018	139.0	43.0	8,250 [E]	8,270 [E]
2019	143.7	42.3	8,120 [E]	8,290 [E]
2020	144.3	41.7	8,250 [E]	8,310 [E]
EPA Mass Emission Performance Goal For Antidegradation Assessment [F]			8,018	

Table S-10 Notes:

A Computed as the average of all PLWTP effluent daily values of ammonia-nitrogen during the listed year. This value may vary from annual average PLWTP ammonia-nitrogen concentrations listed in monitoring reports submitted to the RWQCB, as the annual average values in the submitted monitoring reports were determined by averaging monthly average (as opposed to individual daily) PLWTP effluent ammonia-nitrogen concentrations during the year.

B Compliance Determination VII.J.4.d of Order No. R9-2017-0007 requires that the MER in pounds per day be computed as the product of the PLWTP flow in mgd (Q) and the ammonia concentration in mg/L (C), as follows: $MER\ (lbs/day) = Q \cdot C \cdot 8.34$. The above MER values are rounded to three significant figures. Calendar year 2020 is the most recent year for which a complete 12-month data set was available at the time of preparation of this report. Data for calendar year 2021 will be electronically transmitted to regulators under separate cover at a later date.

C MER values in this column are computed on the basis of the average annual PLWTP flow during the listed year multiplied by the average annual PLWTP ammonia concentration during the year, converted to units of metric tons per year. While this method allows for rapid estimation of annual mass emissions, the method is not entirely accurate, as this method may not be reflective of mass emissions that occur as a result of peak day flows coinciding with peak ammonia concentrations.

D MER values shown in this column are computed as the cumulative total of all daily mass emissions during the listed year. On days where ammonia samples were not available, the ammonia concentration from the prior sample was used to compute the ammonia mass emission during that day. This MER computational method is considered more accurate than the method of Footnote C, as the "average flow multiplied by an average concentration" method of Footnote C may not be reflective of peak day mass emissions that occur when high ammonia concentrations occur on days of peak PLWTP flow.

E Annual value exceeds the EPA antidegradation-based mass emission performance goal established in Table 7 of Order No. R9-2017-0007. See Antidegradation Analysis (Volume II) of this NPDES application.

F The 8,018 mt/year ammonia benchmark established within Table 7 of Order No. R9-2017-0007 is based on the PLWTP permitted flow of 205 mgd and the n-day average monthly performance (95th percentile) PLWTP ammonia MER during 1990-1995. This 8,018 mt/year ammonia benchmark was implemented to establish a framework for evaluating the need for antidegradation analysis. Exceedance of this metric is indicative that PLOO ammonia MER levels have increased beyond those of 1990-1995 and that additional analysis may be required to demonstrate compliance with antidegradation regulations.

S.7 CONCLUSIONS

The discharge of ammonia-nitrogen from the PLOO does not result in toxic concentrations of un-ionized ammonia in the receiving waters. Maximum computed receiving water concentrations of ammonia-nitrogen are projected to be significantly less than Ocean Plan water quality objectives and applicable federal water quality criteria. PLOO mass emissions of ammonia-nitrogen remain significantly below the Ocean Plan-based performance goal mass emission levels established in Order No. R9-2017-0007. PLOO mass emissions of ammonia also remain below the antidegradation mass emission benchmarks established by EPA.

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APPENDIX T

CALIFORNIA OCEAN PLAN

City of San Diego
Public Utilities Department

March 2022

State of California
Gavin Newsom Governor

California Environmental Protection Agency
Jared Blumenfeld, Secretary

State Water Resources Control Board
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Ivy Liao, 10th Grade, 2012
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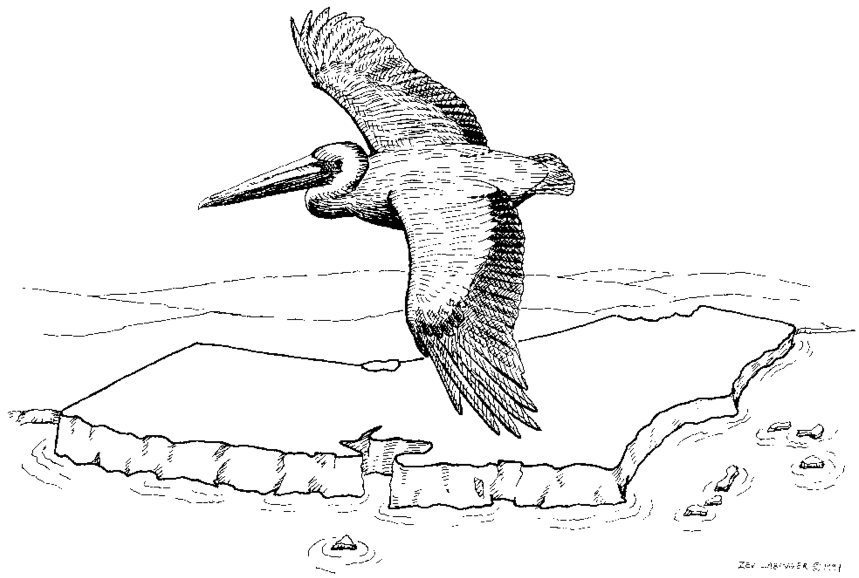
State of California

STATE WATER RESOURCES CONTROL BOARD



Established 1972
Revised 2019

CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN

OCEAN WATERS OF CALIFORNIA

Amendments to the Water Quality Control Plan for Ocean Waters of California

Name	Date Adopted	Resolution Number	Effective Date
Amendment to the Water Quality Control Plan for Ocean Waters of California – Bacteria Provisions and a Water Quality Standards Variance Policy	8/7/2018	2018-0038	2/4/2019
Amendment to the statewide Ocean Plan of California addressing desalination facility intakes, brine discharges, and to incorporate other non-substantive changes	5/6/2015	2015-0033	1/28/2016
Amendment to the Water Quality Control Plan for Ocean Waters of California to control trash and part 1 trash provisions of the Water Quality Control Plan for inland surface waters, enclosed bays, and estuaries in California	4/7/2015	2015-0019	1/12/2016
Adoption of the California Ocean Plan Amendments regarding model monitoring, vessel discharges, and non-substantive changes	10/16/2012	2012-0057	7/1/2013
Adopting the California Ocean Plan Amendment implementing State Water Board resolutions 2010-0057 and 2011-013 regarding State Water Quality Protection Areas and Marine Protected Areas	10/16/2012	2012-0056	7/1/2013
Adoption of Proposed Amendments to the California Ocean Plan regarding total recoverable metals, compliance schedules, toxicity definitions, and the list of exceptions	9/15/2009	2009-0072	3/10/2010
Amendment to the California Ocean Plan: (1) Reasonable Potential, Determining When California Ocean Plan Water Quality-Based Effluent Limitations are Required, and (2) Minor Changes to the Areas of Special Biological Significance, and Exception Provisions	4/21/2005	2005-0035	10/12/2005
Amendment to California Ocean Plan Water Contact Bacterial Standards	1/20/2005	2005-0013	10/12/2005
Adoption of the Proposed Amendments to the California Ocean Plan regarding Table A, chemical water quality objectives, provisions of compliance, special protection for water quality and designated uses, and administrative changes	11/16/2000	2000-108	12/3/2001
Adoption of an Amendment to the Water Quality Control Plan for Ocean Waters of California regarding revisions to the list of critical life stage protocols used in testing the toxicity of waste discharges	3/20/1997	97-026	7/23/1997

Name	Date Adopted	Resolution Number	Effective Date
Approval of Amendment to the Water Quality Control Plan for Ocean Waters of California regarding new water quality objectives in Table B	3/22/1990	90-027	3/22/1990
Water Quality Control Plan for Ocean Waters of California, California Ocean Plan	9/22/1988	88-111	9/22/1988
Water Quality Control Plan for Ocean Waters of California	11/17/1983	83-087	11/17/1983
Water Quality Control Plan for Ocean Waters of California	1/19/1978	78-002	1/19/1978
Water Quality Control Plan for Ocean Waters of California	7/6/1972	72-045	7/6/1972

CALIFORNIA OCEAN PLAN
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CALIFORNIA OCEAN PLAN
WATER QUALITY CONTROL PLAN FOR
OCEAN WATERS OF CALIFORNIA

INTRODUCTION

A. Purpose and Authority

1. In furtherance of legislative policy set forth in section 13000 of Division 7 of the California Water Code (CWC) (Stats. 1969, Chap. 482) pursuant to the authority contained in section 13170 and 13170.2 (Stats. 1971, Chap. 1288) the State Water Resources Control Board (State Water Board) hereby finds and declares that protection of the quality of the ocean* waters for use and enjoyment by the people of the State requires control of the discharge of waste* to ocean* waters and control of intake seawater* in accordance with the provisions contained herein. The Board finds further that this plan shall be reviewed at least every three years to guarantee that the current standards are adequate and are not allowing degradation* to marine species or posing a threat to public health.

B. Principles

1. Harmony Among Water Quality Control Plans and Policies.

   a. In the adoption and amendment of water quality control plans, it is the intent of this Board that each plan will provide for the attainment and maintenance of the water quality standards of downstream waters.*

   b. To the extent there is a conflict between a provision of this plan and a provision of another statewide plan or policy, or a regional water quality control plan (basin plan), the more stringent provision shall apply except where pursuant to Chap. III.J of this Plan, the State Water Board has approved an exception to the Plan requirements, and except in chapter III.M, in which the provisions of this plan shall govern.

C. Applicability

1. This plan is applicable, in its entirety, to point source discharges to the ocean.* Nonpoint sources of waste* discharges to the ocean* are subject to Chapter I Beneficial Uses, Chapter II - WATER QUALITY OBJECTIVES (wherein compliance with water quality objectives shall, in all cases, be determined by direct measurements in the receiving waters*) and Chapter III - PROGRAM OF IMPLEMENTATION Parts A.2, D, E, and I.

2. This plan is not applicable to discharges to enclosed* bays and estuaries* or inland waters or the control of dredged material.*

* See Appendix I for definition of terms.

3. Provisions regulating the thermal aspects of waste* discharged to the ocean* are set forth in the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed* Bays and Estuaries* of California.

4. Provisions regulating the intake of seawater* for desalination facilities* are established pursuant to the authority contained in section 13142.5 subdivision (b) of the California Water Code (Stats. 1976, Chap. 1330).

5. Within this Plan, references to the State Board or State Water Board shall mean the State Water Resources Control Board. References to a Regional Board or Regional Water Board shall mean a California Regional Water Quality Control Board. References to the Environmental Protection Agency, USEPA, or EPA shall mean the federal Environmental Protection Agency.

* See Appendix I for definition of terms.

I. BENEFICIAL USES

A. The beneficial uses of the ocean* waters of the State that shall be protected include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture*; preservation and enhancement of designated Areas* of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish* harvesting.

* See Appendix I for definition of terms.

II. WATER QUALITY OBJECTIVES

A. General Provisions

1. This chapter sets forth limits or levels of water quality characteristics for ocean* waters to ensure the reasonable protection of beneficial uses and the prevention of nuisance. The discharge of waste* shall not cause violation of these objectives.

2. The Water Quality Objectives and Effluent Limitations are defined by a statistical distribution when appropriate. This method recognizes the normally occurring variations in treatment efficiency and sampling and analytical techniques and does not condone poor operating practices.

3. Compliance with the water quality objectives of this chapter shall be determined from samples collected at stations representative of the area within the waste* field where initial* dilution is completed.

B. Bacterial Characteristics

1. Water-Contact Standards

   Subsection (a) of this section contains bacteria water quality objectives* adopted by the State Water Board for ocean waters* used for water contact recreation. Subsection (b) describes the beach notification levels for waters adjacent to public beaches and public water contact sports areas in ocean waters*.

   a. State Water Board Water-Contact Objectives

      (1) Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline, and in areas outside this zone used for water contact sports, as determined by the Regional Water Board (i.e., waters designated as REC-1), but including all kelp beds*, the following water quality objectives* shall be maintained throughout the water column.

      Fecal coliform

      A 30-day geometric mean* (GM) of fecal coliform density not to exceed 200 per 100 milliliters (mL), calculated based on the five most recent samples from each site, and a single sample maximum* (SSM) not to exceed 400 per 100 mL.

* See Appendix I for definition of terms.

Table 1. Fecal Coliform REC-1 Water Quality Objective for Water-Contact in Ocean Waters*

Indicator	Magnitude	Magnitude
	30-day GM*	SSM*
Fecal coliform density	200 per 100 mL	400 per 100 mL

GM* = geometric mean
SSM* = single sample maximum
mL = milliliter

Enterococci

A six-week rolling GM***** of enterococci not to exceed 30 colony forming units (cfu) per 100 milliliters (mL), calculated weekly, and a statistical threshold value* (STV) of 110 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month*, calculated in a static manner. U.S. EPA recommends using U.S. EPA Method 1600 or other equivalent method to measure culturable enterococci.

Table 2. Enterococci REC-1 Water Quality Objective for Water-Contact in Ocean Waters*

Indicator	**Estimated Illness Rate (NGI):** 32 per 1,000 water contact recreators	
	Magnitude	
	GM* (cfu/100 mL)	STV* (cfu/100 mL)
Enterococci	30	110

The waterbody GM* shall not be greater than the GM* magnitude in any six-week interval, calculated weekly. The STV* shall not be exceeded by more than 10 percent of the samples collected in a calendar month*, calculated in a static manner.

NGI = National Epidemiological and Environmental Assessment of Recreational Water gastrointestinal illness rate
GM* = geometric mean cfu = colony forming units
STV* = statistical threshold value mL = milliliter

* See Appendix I for definition of terms.

Water Quality Standards Assessment

When applying the listing and delisting factors contained in the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List, the GM*, SSM*, and STV* shall be used as follows, unless a situation-specific weight of the evidence factor is being applied: Only the GM* value shall be applied based on a statistically sufficient number of samples, which is generally not less than five samples distributed over a six-week period. However, if a statistically sufficient number of samples is not available to calculate the GM*, then attainment of the water quality objective shall be determined based only on the SSM* or STV*. When applying the situation-specific weight of the evidence factor for listing or delisting decisions, any available beach use or beach closure information shall be evaluated.

(2) The "Initial Dilution* Zone" of wastewater outfalls shall be excluded from designation as "kelp beds*" for purposes of bacterial standards, and Regional Water Boards should recommend extension of such exclusion zone where warranted to the State Water Board (for consideration under Chapter III. J.). Adventitious assemblages of kelp plants on waste discharge structures (e.g., outfall pipes and diffusers) do not constitute kelp beds* for purposes of bacterial standards.

b. Beach Notification Levels

Minimum protective bacteriological standards for waters adjacent to public beaches and for public water-contact sports areas in ocean waters* are established in the California Code of Regulations, Title 17 (beginning at div. 1, ch. 5, § 7958 et seq.). When a public beach or public water-contact sports area fails to meet the standards, the California Department of Public Health or the local public health officer may post with warning signs or otherwise restrict use of the public beach or public water-contact sports area until the standards are met. The regulations impose more frequent monitoring and more stringent posting and closure requirements on certain high-use public beaches that are located adjacent to a storm drain that flows in the summer. The Title 17 bacteriological standards are not water quality objectives.

2. Shellfish* Harvesting Standards

a. At all areas where shellfish* may be harvested for human consumption, as determined by the Regional Water Board, the following bacterial objectives shall be maintained throughout the water column:

(1) The median total coliform density shall not exceed 70 per 100 mL, and not more than 10 percent of the samples shall exceed 230 per 100 mL.

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* See Appendix I for definition of terms.

C. Physical Characteristics

1. Floating particulates and grease and oil shall not be visible.

2. The discharge of waste* shall not cause aesthetically undesirable discoloration of the ocean* surface.

3. Natural light* shall not be significantly* reduced at any point outside the initial* dilution zone as the result of the discharge of waste.*

4. The rate of deposition of inert solids and the characteristics of inert solids in ocean* sediments shall not be changed such that benthic communities are degraded.*

5. Trash* shall not be present in ocean waters, along shorelines or adjacent areas in amounts that adversely affect beneficial uses or cause nuisance.

D. Chemical Characteristics

1. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste* materials.*

2. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.

3. The dissolved sulfide concentration of waters in and near sediments shall not be significantly* increased above that present under natural conditions.

4. The concentration of substances set forth in chapter II, Table 3, in marine sediments shall not be increased to levels which would degrade* indigenous biota.

5. The concentration of organic materials* in marine sediments shall not be increased to levels that would degrade* marine life.

6. Nutrient materials* shall not cause objectionable aquatic growths or degrade* indigenous biota.

7. Numerical Water Quality Objectives

   a. Table 3 water quality objectives apply to all discharges within the jurisdiction of this Plan. Unless otherwise specified, all metal concentrations are expressed as total recoverable concentrations.

   b. Table 3 Water Quality Objectives

* See Appendix I for definition of terms.

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded.*

2. The natural taste, odor, and color of fish, shellfish,* or other marine resources used for human consumption shall not be altered.

3. The concentration of organic materials* in fish, shellfish* or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

F. Radioactivity

1. Discharge of radioactive waste* shall not degrade* marine life.

* See Appendix I for definition of terms.

Table 3 (formerly Table B): Water Quality Objectives

OBJECTIVES FOR PROTECTION OF MARINE AQUATIC LIFE

	Units of Measurement	Limiting Concentration: 6-Month Median	Limiting Concentration: Daily Maximum	Limiting Concentration: Instantaneous Maximum
Arsenic	µg/L	8.	32.	80.
Cadmium	µg/L	1.	4.	10.
Chromium (Hexavalent) (see below, a)	µg/L	2.	8.	20.
Copper	µg/L	3.	12.	30.
Lead	µg/L	2.	8.	20.
Mercury	µg/L	0.04	0.16	0.4
Nickel	µg/L	5.	20.	50.
Selenium	µg/L	15.	60.	150.
Silver	µg/L	0.7	2.8	7.
Zinc	µg/L	20.	80.	200.
Cyanide (see below, b)	µg/L	1.	4.	10.
Total Chlorine Residual (For intermittent chlorine sources see below, c)	µg/L	2.	8.	60.
Ammonia (expressed as nitrogen)	µg/L	600.	2400.	6000.
Acute* Toxicity	TUa	N/A	0.3	N/A
Chronic* Toxicity	TUc	N/A	1.	N/A
Phenolic Compounds (non-chlorinated)	µg/L	30.	120.	300.
Chlorinated Phenolics	µg/L	1.	4.	10.
Endosulfan*	µg/L	0.009	0.018	0.027
Endrin	µg/L	0.002	0.004	0.006
HCH*	µg/L	0.004	0.008	0.012
Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, section 30253 of the California Code of Regulations. Reference to section 30253 is prospective, including future changes to any incorporated provisions of federal law, as the changes take effect.			

* See Appendix I for definition of terms.

Table 3 (formerly Table B) Continued

OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – NONCARCINOGENS

Chemical	30-day Average (µg/L): Decimal Notation	30-day Average (µg/L): Scientific Notation
Acrolein	220.	2.2×10^{2}
Antimony	1,200.	1.2×10^{3}
bis(2-chloroethoxy) methane	4.4	4.4×10^{0}
bis(2-chloroisopropyl) ether	1,200.	1.2×10^{3}
chlorobenzene	570.	5.7×10^{2}
chromium (III)	190,000.	1.9×10^{5}
di-n-butyl phthalate	3,500.	3.5×10^{3}
dichlorobenzenes*	5,100.	5.1×10^{3}
diethyl phthalate	33,000.	3.3×10^{4}
dimethyl phthalate	820,000.	8.2×10^{5}
4,6-dinitro-2-methylphenol	220.	2.2×10^{2}
2,4-dinitrophenol	4.0	4.0×10^{0}
ethylbenzene	4,100.	4.1×10^{3}
fluoranthene	15.	1.5×10^{1}
hexachlorocyclopentadiene	58.	5.8×10^{1}
nitrobenzene	4.9	4.9×10^{0}
thallium	2.	$2. \times 10^{0}$
toluene	85,000.	8.5×10^{4}
tributyltin	0.0014	1.4×10^{-3}
1,1,1-trichloroethane	540,000.	5.4×10^{5}

Table 3 (formerly Table B) Continued

OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS

Chemical	30-day Average (µg/L): Decimal Notation	30-day Average (µg/L): Scientific Notation
acrylonitrile	0.10	1.0×10^{-1}
aldrin	0.000022	2.2×10^{-5}
benzene	5.9	5.9×10^{0}
benzidine	0.000069	6.9×10^{-5}
beryllium	0.033	3.3×10^{-2}
bis(2-chloroethyl) ether	0.045	4.5×10^{-2}
bis(2-ethylhexyl) phthalate	3.5	3.5×10^{0}
carbon tetrachloride	0.90	9.0×10^{-1}
chlordane*	0.000023	2.3×10^{-5}
chlorodibromomethane	8.6	8.6×10^{0}
chloroform	130.	1.3×10^{2}

* See Appendix I for definition of terms.

Chemical	30-day Average (μg/L): Decimal Notation	30-day Average (μg/L): Scientific Notation
DDT*	0.00017	1.7×10^{-4}
1,4-dichlorobenzene	18.	1.8×10^{1}
3,3'-dichlorobenzidine	0.0081	8.1×10^{-3}
1,2-dichloroethane	28.	2.8×10^{1}
1,1-dichloroethylene	0.9	9×10^{-1}
dichlorobromomethane	6.2	6.2×10^{0}
dichloromethane	450.	4.5×10^{2}
1,3-dichloropropene	8.9	8.9×10^{0}
dieldrin	0.00004	4.0×10^{-5}
2,4-dinitrotoluene	2.6	2.6×10^{0}
1,2-diphenylhydrazine	0.16	1.6×10^{-1}
halomethanes*	130.	1.3×10^{2}
heptachlor	0.00005	5×10^{-5}
heptachlor epoxide	0.00002	2×10^{-5}
hexachlorobenzene	0.00021	2.1×10^{-4}
hexachlorobutadiene	14.	1.4×10^{1}
hexachloroethane	2.5	2.5×10^{0}
isophorone	730.	7.3×10^{2}
N-nitrosodimethylamine	7.3	7.3×10^{0}
N-nitrosodi-N-propylamine	0.38	3.8×10^{-1}
N-nitrosodiphenylamine	2.5	2.5×10^{0}
PAHs*	0.0088	8.8×10^{-3}
PCBs*	0.000019	1.9×10^{-5}
TCDD equivalents*	0.0000000039	3.9×10^{-9}
1,1,2,2-tetrachloroethane	2.3	2.3×10^{0}
tetrachloroethylene	2.0	2.0×10^{0}
toxaphene	0.00021	2.1×10^{-4}
trichloroethylene	27.	2.7×10^{1}
1,1,2-trichloroethane	9.4	9.4×10^{0}
2,4,6-trichlorophenol	0.29	2.9×10^{-1}
vinyl chloride	36.	3.6×10^{1}

Table 3 Notes:

a) Dischargers may at their option meet this objective as a total chromium objective.

b) If a discharger can demonstrate to the satisfaction of the Regional Water Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide

* See Appendix I for definition of terms.

from metal complexes must be comparable to that achieved by the approved method in 40 CFR PART 136, as revised May 14, 1999.

c) Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours, shall be determined through the use of the following equation:

$$\log y = -0.43 (\log x) + 1.8$$

where: y = the water quality objective (in µg/L) to apply when chlorine is being discharged;
x = the duration of uninterrupted chlorine discharge in minutes.

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* See Appendix I for definition of terms.

III. PROGRAM OF IMPLEMENTATION

A. General Provisions

1. Effective Date

   a. The *Water Quality Control Plan, Ocean Waters of California, California Ocean Plan* was adopted and has been effective since 1972. There have been multiple amendments of the Ocean Plan since its adoption.

2. General Requirements For Management Of Waste Discharge To The Ocean*

   a. Waste* management systems that discharge to the ocean* must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.

   b. Waste* discharged to the ocean* must be essentially free of:

      (1) Material* that is floatable or will become floatable upon discharge.

      (2) Settleable material* or substances that may form sediments which will degrade* benthic communities or other aquatic life.

      (3) Substances which will accumulate to toxic levels in marine waters, sediments or biota.

      (4) Substances that significantly* decrease the natural light* to benthic communities and other marine life.

      (5) Materials* that result in aesthetically undesirable discoloration of the ocean* surface.

   c. Waste* effluents shall be discharged in a manner which provides sufficient initial* dilution to minimize the concentrations of substances not removed in the treatment.

   d. Location of waste* discharges must be determined after a detailed assessment of the oceanographic characteristics and current patterns to assure that:

      (1) Pathogenic organisms and viruses are not present in areas where shellfish* are harvested for human consumption or in areas used for swimming or other body-contact sports.

      (2) Natural water quality conditions are not altered in areas designated as being of special biological significance or areas that existing marine laboratories use as a source of seawater.*

* See Appendix I for definition of terms.

(3) Maximum protection is provided to the marine environment.

e. Waste* that contains pathogenic organisms or viruses should be discharged a sufficient distance from shellfishing* and water-contact sports areas to maintain applicable bacterial standards without disinfection. Where conditions are such that an adequate distance cannot be attained, reliable disinfection in conjunction with a reasonable separation of the discharge point from the area of use must be provided. Disinfection procedures that do not increase effluent toxicity and that constitute the least environmental and human hazard should be used.

3. Areas of Special Biological Significance*

a. ASBS* shall be designated by the State Water Board following the procedures provided in Appendix IV. A list of ASBS* is available in Appendix V.

4. Combined Sewer Overflow: Not withstanding any other provisions in this plan, discharges from the City of San Francisco's combined sewer system are subject to the US EPA's Combined Sewer Overflow Policy.

B. Table 4 Effluent Limitation

Table 4 (formerly Table A): Effluent Limitations

	Unit of Measurement	**Limiting Concentration: Monthly (30-day Average)**	**Limiting Concentration: Weekly (7-day Average)**	**Limiting Concentration: Maximum at any time**
Grease and Oil	mg/L	25.	40.	75.
Suspended Solids			See below +	
Settleable Solids	mL/L	1.0	1.5	3.0
Turbidity	NTU	75.	100.	225.
pH	Units		Within limit of 6.0 to 9.0 at all times	

Table 4 Notes:

\+ Suspended Solids: Dischargers shall, as a 30-day average, remove 75% of suspended solids from the influent stream before discharging wastewaters to the ocean,* except that the effluent limitation to be met shall not be lower than 60 mg/l. Regional Boards may recommend that the State Water Board (chapter III section J), with the concurrence of the Environmental Protection Agency, adjust the lower effluent concentration limit (the 60 mg/l above) to suit the environmental and effluent characteristics of the discharge. As a further consideration in making such recommendation for adjustment, Regional Water Boards should evaluate effects on existing and potential water* reclamation projects.

* See Appendix I for definition of terms.

If the lower effluent concentration limit is adjusted, the discharger shall remove 75% of suspended solids from the influent stream at any time the influent concentration exceeds four times such adjusted effluent limit.

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1. Table 4 effluent limitations apply only to publicly owned treatment works and industrial discharges for which Effluent Limitations Guidelines have not been established pursuant to sections 301, 302, 304, or 306 of the Federal Clean Water Act.

2. Table 4 effluent limitations shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.
3. The State Water Board is authorized to administer and enforce effluent limitations established pursuant to the Federal Clean Water Act. Effluent limitations established under sections 301, 302, 306, 307, 316, 403, and 405 of the aforementioned Federal Act and administrative procedures pertaining thereto are included in this plan by reference. Compliance with Table 4 effluent limitations, or Environmental Protection Agency Effluent Limitations Guidelines for industrial discharges, based on Best Practicable Control Technology, shall be the minimum level* of treatment acceptable under this plan, and shall define reasonable treatment and waste* control technology.
4. Compliance with Table 4 effluent limitations for brine discharges from desalination facilities that commingle brine and wastewater prior to discharge to the ocean may be measured after the brine has been commingled with wastewater, provided that the permittee for the commingled discharge accepts responsibly for any exceedances of the Table 4 effluent limitations.

C. Implementation Provisions for Table 3

1. Effluent concentrations calculated from Table 3 water quality objectives shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.

2. If the Regional Water Board determines, using the procedures in Appendix VI, that a pollutant is discharged into ocean* waters at levels which will cause, have the reasonable potential to cause, or contribute to an excursion above a Table 3 water quality objective, the Regional Water Board shall incorporate a water quality-based effluent limitation in the Waste Discharge Requirement for the discharge of that pollutant.

3. Effluent limitations shall be imposed in a manner prescribed by the State Water Board such that the concentrations set forth below as water quality objectives shall not be exceeded in the receiving water* upon completion of initial* dilution, except that objectives indicated for radioactivity shall apply directly to the undiluted waste* effluent.

* See Appendix I for definition of terms.

4. Calculation of Effluent Limitations

   a. Effluent limitations for water quality objectives listed in Table 3, with the exception of acute toxicity and radioactivity, shall be determined through the use of the following equation:

   Equation 1: $Ce = Co + Dm (Co - Cs)$

   where:

   Ce = the effluent concentration limit, µg/L

   Co = the concentration (water quality objective) to be met at the completion of initial* dilution, µg/L

   Cs = background seawater* concentration (see Table 5 below, with all metals expressed as total recoverable concentrations), µg/L

   Dm = minimum probable initial* dilution expressed as parts seawater* per part wastewater.

Table 5 (formerly Table C): Background Seawater* Concentrations (Cs)

Waste Constituent	**Cs (µg/L)**
Arsenic	3.
Copper	2.
Mercury	0.0005
Silver	0.16
Zinc	8.
For all other Table 3 parameters	Cs = 0

   b. Determining a Mixing Zone for the Acute Toxicity* Objective

   The mixing zone for the acute toxicity* objective shall be ten percent (10%) of the distance from the edge of the outfall structure to the edge of the chronic mixing zone (zone of initial dilution*). There is no vertical limitation on this zone. The effluent limitation for the acute toxicity* objective listed in Table 3 shall be determined through the use of the following equation:

* See Appendix I for definition of terms.

Equation 2: Ce = Ca + (0.1) Dm (Ca)

where:

Ca = the concentration (water quality objective) to be met at the edge of the acute mixing zone.

Dm = minimum probable initial* dilution expressed as parts seawater* per part wastewater (This equation applies only when Dm > 24).

c. Toxicity Testing Requirements based on the Minimum Initial* Dilution Factor for Ocean Waste* Discharges

(1) Dischargers shall conduct acute toxicity* testing if the minimum initial* dilution of the effluent is greater than 1,000:1 at the edge of the mixing zone.

(2) Dischargers shall conduct either acute or chronic toxicity* testing if the minimum initial* dilution ranges from 350:1 to 1,000:1 depending on the specific discharge conditions. The Regional Water Board shall make this determination.

(3) Dischargers shall conduct chronic toxicity* testing for ocean waste* discharges with minimum initial* dilution factors ranging from 100:1 to 350:1. The Regional Water Board may require that acute toxicity* testing be conducted in addition to chronic as necessary for the protection of beneficial uses of ocean* waters.

(4) Dischargers shall conduct chronic toxicity* testing if the minimum initial* dilution of the effluent falls below 100:1 at the edge of the mixing zone.

d. For the purpose of this Plan, minimum initial* dilution is the lowest average initial* dilution within any single month of the year. Dilution estimates shall be based on observed waste* flow characteristics, observed receiving water* density structure, and the assumption that no currents, of sufficient strength to influence the initial* dilution process, flow across the discharge structure.

e. The Executive Director of the State Water Board shall identify standard dilution models for use in determining Dm, and shall assist the Regional Board in evaluating Dm for specific waste* discharges. Dischargers may propose alternative methods of calculating Dm, and the Regional Board may accept such methods upon verification of its accuracy and applicability.

f. The six-month median shall apply as a moving median of daily values for any 180-day period in which daily values represent flow weighted average concentrations within a 24-hour period. For intermittent discharges, the daily

* See Appendix I for definition of terms.

value shall be considered to equal zero for days on which no discharge occurred.

g. The daily maximum shall apply to flow weighted 24 hour composite samples.

h. The instantaneous maximum shall apply to grab sample determinations.

i. If only one sample is collected during the time period associated with the water quality objective (e.g., 30-day average or 6-month median), the single measurement shall be used to determine compliance with the effluent limitation for the entire time period.

j. Discharge requirements shall also specify effluent limitations in terms of mass emission rate limits utilizing the general formula:

Equation 3: lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit, µg/L

Q = flow rate, million gallons per day (MGD)

k. The six-month median limit on daily mass emissions shall be determined using the six-month median effluent concentration as Ce and the observed flow rate Q in millions of gallons per day. The daily maximum mass emission shall be determined using the daily maximum effluent concentration limit as Ce and the observed flow rate Q in millions of gallons per day.

l. Any significant* change in waste* flow shall be cause for reevaluating effluent limitations.

5. Minimum* Levels

For each numeric effluent limitation, the Regional Board must select one or more Minimum* Levels (and their associated analytical methods) for inclusion in the permit. The “reported” Minimum* Level is the Minimum* Level (and its associated analytical method) chosen by the discharger for reporting and compliance determination from the Minimum* Levels included in their permit.

a. Selection of Minimum* Levels from Appendix II

The Regional Water Board must select all Minimum* Levels from Appendix II that are below the effluent limitation. If the effluent limitation is lower than all the Minimum* Levels in Appendix II, the Regional Board must select the lowest Minimum* Level from Appendix II.

b. Deviations from Minimum* Levels in Appendix II

* See Appendix I for definition of terms.

The Regional Board, in consultation with the State Water Board's Quality Assurance Program, must establish a Minimum* Level to be included in the permit in any of the following situations:

1. A pollutant is not listed in Appendix II.

2. The discharger agrees to use a test method that is more sensitive than those described in 40 CFR 136 (revised May 14, 1999).

3. The discharger agrees to use a Minimum* Level lower than those listed in Appendix II.

4. The discharger demonstrates that their calibration standard matrix is sufficiently different from that used to establish the Minimum* Level in Appendix II and proposes an appropriate Minimum* Level for their matrix.

5. A discharger uses an analytical method having a quantification practice that is not consistent with the definition of Minimum* Level (e.g., US EPA methods 1613, 1624, 1625).

6. Use of Minimum* Levels

a. Minimum* Levels in Appendix II represent the lowest quantifiable concentration in a sample based on the proper application of method-specific analytical procedures and the absence of matrix interferences. Minimum* Levels also represent the lowest standard concentration in the calibration curve for a specific analytical technique after the application of appropriate method-specific factors.

Common analytical practices may require different treatment of the sample relative to the calibration standard. Some examples are given below:

Substance or Grouping	**Method-Specific Treatment**	**Most Common Factor**
Volatile Organics	No differential treatment	1
Semi-Volatile Organics	Samples concentrated by extraction	1000
Metals	Samples diluted or concentrated	½ , 2 , and 4
Pesticides	Samples concentrated by extraction	100

b. Other factors may be applied to the Minimum* Level depending on the specific sample preparation steps employed. For example, the treatment typically applied when there are matrix effects is to dilute the sample or

* See Appendix I for definition of terms.

sample aliquot by a factor of ten. In such cases, this additional factor must be applied during the computation of the reporting limit. Application of such factors will alter the reported Minimum* Level.

c. Dischargers are to instruct their laboratories to establish calibration standards so that the Minimum* Level (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the discharger to use analytical data derived from *extrapolation* beyond the lowest point of the calibration curve. In accordance with section 4b, above, the discharger's laboratory may employ a calibration standard lower than the Minimum* Level in Appendix II.

7. Sample Reporting Protocols

a. Dischargers must report with each sample result the reported Minimum* Level (selected in accordance with section 4, above) and the laboratory's current MDL.*

b. Dischargers must also report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

(1) Sample results greater than or equal to the reported Minimum* Level must be reported "as measured" by the laboratory (i.e., the measured chemical concentration in the sample).

(2) Sample results less than the reported Minimum* Level, but greater than or equal to the laboratory's MDL,* must be reported as "Detected, but Not Quantified", or DNQ. The laboratory must write the estimated chemical concentration of the sample next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc.").

(3) Sample results less than the laboratory's MDL* must be reported as "Not Detected", or ND.

8. Compliance Determination

Sufficient sampling and analysis shall be required to determine compliance with the effluent limitation.

a. Compliance with Single-Constituent Effluent Limitations

Dischargers are out of compliance with the effluent limitation if the concentration of the pollutant (see section 7c, below) in the monitoring sample is greater than the effluent limitation and greater than or equal to the reported Minimum* Level.

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* See Appendix I for definition of terms.

b. Compliance with Effluent Limitations expressed as a Sum of Several Constituents

Dischargers are out of compliance with an effluent limitation which applies to the sum of a group of chemicals (e.g., PCBs*) if the sum of the individual pollutant concentrations is greater than the effluent limitation. Individual pollutants of the group will be considered to have a concentration of zero if the constituent is reported as ND or DNQ.

c. Multiple Sample Data Reduction

The concentration of the pollutant in the effluent may be estimated from the result of a single sample analysis or by a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple sample analyses when all sample results are quantifiable (i.e., greater than or equal to the reported Minimum* Level). When one or more sample results are reported as ND or DNQ, the central tendency concentration of the pollutant shall be the median (middle) value of the multiple samples. If, in an even number of samples, one or both of the middle values is ND or DNQ, the median will be the lower of the two middle values.

d. Powerplants and Heat Exchange Dischargers

Due to the large total volume of powerplant and other heat exchange discharges, special procedures must be applied for determining compliance with Table 3 objectives on a routine basis. Effluent concentration values (Ce) shall be determined through the use of equation 1 considering the minimal probable initial* dilution of the combined effluent (in-plant waste* streams plus cooling water flow). These concentration values shall then be converted to mass emission limitations as indicated in equation 3. The mass emission limits will then serve as requirements applied to all in-plant waste* streams taken together which discharge into the cooling water flow, except that limits for total chlorine residual, acute (if applicable per section (3)(c)) and chronic* toxicity* and instantaneous maximum concentrations in Table 3 shall apply to, and be measured in, the combined final effluent, as adjusted for dilution with ocean water. The Table 3 objective for radioactivity shall apply to the undiluted combined final effluent.

9. Pollutant Minimization Program

a. Pollutant Minimization Program Goal

The goal of the Pollutant Minimization Program is to reduce all potential sources of a pollutant through pollutant minimization (control) strategies, including pollution prevention measures, in order to maintain the effluent concentration at or below the effluent limitation.

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* See Appendix I for definition of terms.

Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The completion and implementation of a Pollution Prevention Plan, required in accordance with CA Water Code section 13263.3 (d) will fulfill the Pollution Minimization Program requirements in this section.

b. Determining the need for a Pollutant Minimization Program

1. The discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:

(a) The calculated effluent limitation is less than the reported Minimum Level*

(b) The concentration of the pollutant is reported as DNQ

(c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.

2. Alternatively, the discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:

(a) The calculated effluent limitation is less than the Method Detection Limit.*

(b) The concentration of the pollutant is reported as ND.

(c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.

c. Regional Water Boards may include special provisions in the discharge requirements to require the gathering of evidence to determine whether the pollutant is present in the effluent at levels above the calculated effluent limitation. Examples of evidence may include:

1. health advisories for fish consumption,

2. presence of whole effluent toxicity,

3. results of benthic or aquatic organism tissue sampling,

4. sample results from analytical methods more sensitive than methods included in the permit (in accordance with section 4b, above).

5. the concentration of the pollutant is reported as DNQ and the effluent limitation is less than the MDL*

* See Appendix I for definition of terms.

d. Elements of a Pollutant Minimization Program

The Regional Board may consider cost-effectiveness when establishing the requirements of a Pollutant Minimization Program. The program shall include actions and submittals acceptable to the Regional Board including, but not limited to, the following:

1. An annual review and semi-annual monitoring of potential sources of the reportable pollutant, which may include fish tissue monitoring and other bio-uptake sampling;

2. Quarterly monitoring for the reportable pollutant in the influent to the wastewater treatment system;

3. Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable pollutant in the effluent at or below the calculated effluent limitation;

4. Implementation of appropriate cost-effective control measures for the pollutant, consistent with the control strategy; and,

5. An annual status report that shall be sent to the Regional Board including:

   (a) All Pollutant Minimization Program monitoring results for the previous year;
   (b) A list of potential sources of the reportable pollutant;
   (c) A summary of all action taken in accordance with the control strategy; and,
   (d) A description of actions to be taken in the following year.

10. Toxicity Reduction Requirements

a. If a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table 3, a toxicity reduction evaluation (TRE) is required. The TRE shall include all reasonable steps to identify the source of toxicity. Once the source(s) of toxicity is identified, the discharger shall take all reasonable steps necessary to reduce toxicity to the required level.

b. The following shall be incorporated into waste* discharge requirements: (1) a requirement to conduct a TRE if the discharge consistently exceeds its toxicity effluent limitation, and (2) a provision requiring a discharger to take all reasonable steps to reduce toxicity once the source of toxicity is identified.

D. Implementation Provisions for Bacterial Characteristics

1. Applicability

* See Appendix I for definition of terms.

a. The bacteria water quality objectives* do not supersede any water quality objective for bacteria established by a Regional Water Board for the REC-1 beneficial use after February 4, 2019.

b. Total maximum daily loads (TMDLs) established prior to February 4, 2019 to implement numeric water quality objectives for bacteria to support REC-1 are in effect for numerous ocean waters*. Such TMDLs remain in effect where a bacteria water quality objective* supersedes a water quality objective for bacteria for which the TMDL was established. A Regional Water Board may convene a public meeting to evaluate the effectiveness of the TMDL in attaining the bacteria water quality objective*.

c. The bacteria water quality objectives***** shall be implemented, where applicable, through National Pollutant Discharge Elimination System (NPDES) permits issued pursuant to section 402 of the Clean Water Act, water quality certifications issued pursuant to section 401 of the Clean Water Act, waste discharge requirements, and waivers of waste discharge requirements**.**

d. The GM* and the SSM* or STV* contained in the applicable bacteria water quality objective* shall be applied in all circumstances, except in the context of a TMDL or a basin plan* amendment.

   In the context of a TMDL or a basin plan* amendment, Regional Water Boards may implement a reference system*/antidegradation approach or natural sources exclusion approach in accordance with Chapter III.D.2.b. A TMDL that implements either approach is subject to U.S. EPA's approval authority under Clean Water Act section 303(d) and such a TMDL or a basin plan* amendment that implements either approach may be subject to U.S. EPA's approval authority under Clean Water Act section 303(c).

e. The beach notification levels (Chapter II.B.1.b) for waters adjacent to public beaches and for public water-contact sports areas in ocean waters* will continue to be used for public beach notification programs.

2. Natural Sources of Bacteria

   a. Applicability

      The implementation provisions contained in Chapter III.D.2 apply to municipal stormwater discharges regulated pursuant to Clean Water Act section 402(p) and non-point source discharges except on-site wastewater treatment system discharges. These implementation provisions do not apply to NPDES discharges other than municipal storm water discharges.

   b. Reference System*/Antidegradation Approach and Natural Sources Exclusion Approach

* See Appendix I for definition of terms.

TMDLs include waste load allocations for point sources, load allocations for nonpoint sources, and natural background levels to identify and enumerate each individual source.

In the context of a TMDL or a basin plan* amendment developed to implement the applicable bacteria water quality objective*, a reference system*/antidegradation approach may be utilized to ensure: (1) bacteriological water quality is at least as good as that of an applicable reference system*, and (2) no degradation of existing water quality is allowed when the existing water quality is better than the reference system*. In such circumstances, the TMDL or basin plan* amendment may include a certain frequency of exceedance of the applicable bacteria water quality objective based on the observed exceedance frequency in the applicable reference system* or the targeted waterbody, whichever is less.

In the context of a TMDL or a basin plan* amendment developed to implement the applicable bacteria water quality objective*, a natural source exclusion approach may be utilized after all anthropogenic sources of bacteria are identified, quantified, and controlled. In such circumstances, the TMDL or basin plan* amendment may include a certain frequency of exceedance of the applicable bacteria water quality objective* based on the observed exceedance frequency of the identified and quantified natural sources of bacteria of the targeted waterbody.

E. Implementation Provisions for Marine Managed Areas*

1. Section E addresses the following Marine Managed Areas*:

(a) State Water Quality Protection Areas (SWQPAs)* consisting of:

(1) SWQPA – Areas of Special Biological Significance (ASBS)* designated by the State Water Board that require special protections as defined under section 4 below.

(2) SWQPA – General Protection (GP) designated by the State Water Board to protect water quality within Marine Protected Areas (MPAs) that require protection under the provisions described under section 5 below.

(b) Marine Protected Areas as defined in the California Public Resources Code as State Marine Reserves, State Marine Parks and State Marine Conservation Areas, established by the Fish and Game Commission, or the Parks and Recreation Commission.

2. The designation of State Marine Parks and State Marine Conservation Areas may not serve as the sole basis for new or modified limitations, substantive

* See Appendix I for definition of terms.

conditions, or prohibitions upon existing municipal point source wastewater discharge outfalls. This provision does not apply to State Marine Reserves.

3. The State Water Board may designate SWQPAs* to prevent the undesirable alteration of natural water quality within MPAs. These designations may include either SWQPA-ASBS or SWQPA-GP or in combination. In considering the designation of SWQPAs over MPAs, the State Water Board will consult with the affected Regional Water Quality Control Board, the Department of Fish and Game and the Department of Parks and Recreation, in accordance with the requirements of Appendix IV.

4. Implementation Provisions for SWQPA-ASBS*

   (a) Waste* shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas.

   (b) Regional Water Boards may approve waste* discharge requirements or recommend certification for limited-term (i.e. weeks or months) activities in ASBS.* Limited-term activities include, but are not limited to, activities such as maintenance/repair of existing boat facilities, restoration of sea walls, repair of existing storm water pipes, and replacement/repair of existing bridges. Limited-term activities may result in temporary and short-term changes in existing water quality. Water quality degradation shall be limited to the shortest possible time. The activities must not permanently degrade* water quality or result in water quality lower than that necessary to protect existing uses, and all practical means of minimizing such degradation shall be implemented.

5. Implementation Provisions for SWQPAs-GP*

   (a) Implementation provisions for existing point source wastewater discharges (NPDES)

      (1) An SWQPA-GP shall not be designated over existing permitted point source wastewater outfalls or encroach upon the zone of initial dilution* associated with an existing discharge. This requirement does not apply to discharges less than one million gallons per day.

      (2) Designation of an SWQPA-GP shall not include conditions to move existing point source wastewater outfalls.

      (3) Where a new SWQPA-GP is established in the vicinity of existing municipal wastewater outfalls, there shall be no new or modified limiting condition or prohibitions for the SWQPA-GP relative to those wastewater outfalls.

* See Appendix I for definition of terms.

(4) Regulatory requirements for discharges from existing treated municipal wastewater outfalls shall be derived from the Chapter II – Water Quality Objectives and Chapter III – Program of Implementation.

(b) Implementation provisions for existing seawater* intakes

(1) Existing permitted seawater* intakes other than those serving desalination facilities* must be controlled to minimize entrainment and impingement by using best technology available. Existing permitted seawater* intakes with a capacity less than one million gallons per day are excluded from this requirement.

(2) Existing permitted seawater* intakes serving desalination facilities are governed by the provisions set forth in chapter III.M of this Plan.

(c) Implementation provisions for permitted separate storm sewer system (MS4) discharges and nonpoint source discharges.

(1) Existing waste* discharges are allowed, but shall not cause an undesirable alteration in natural water quality. For purposes of SWQPA-GP, an undesirable alteration in natural water quality means that for intermittent (e.g. wet weather) discharges, Table 3 instantaneous maximum concentrations for chemical constituents, and daily maximum concentrations for chronic toxicity,* must not be exceeded in the receiving water.*

(2) An NPDES permitting authority* may authorize NPDES-permitted non-storm water discharges* to an MS4 with a direct discharge to an SWQPA-GP only to the extent the NPDES permitting authority* finds that the discharge does not cause an undesirable alteration in natural water quality in an SWQPA-GP.

(3) Non-storm water (dry weather) flows are effectively prohibited as required by the applicable permit. Where capacity and infrastructure exists, all dry weather flows shall be diverted to municipal sanitary sewer systems. The permitting authority* may allow discharges essential for emergency response purposes, structural stability, and slope stability, which may include but are not limited the following:

a. Discharges associated with emergency fire fighting operations.
b. Foundation and footing drains
c. Water from crawl space or basement pumps.
d. Hillside dewatering.

(4) The following naturally occurring discharges are allowed:

a. Naturally occurring groundwater seepage via a storm drain

* See Appendix I for definition of terms.

b. Non-anthropogenic flows from a naturally occurring stream via a culvert or storm drain, as long as there are no contributions of anthropogenic runoff.

(5) Existing storm water discharges into an SWQPA-GP shall be characterized and assessed to determine what effect if any these inputs are having on natural water quality in the State Water Quality Protection Area. Such assessments shall include an evaluation of cumulative impacts as well as impacts stemming from individual discharges. Information to be considered shall include:

a. Water quality;
b. Flow;
c. Watershed pollutant sources; and
d. Intertidal and/ or subtidal biological surveys.

Within each SWQPA-GP the assessment shall be used to rank these existing discharges into low, medium and high threat impact categories. Cumulative impacts will be ranked similarly as well.

(6) An initial analysis shall be performed for pre- and post-storm receiving water* quality of Table 3 constituents and chronic toxicity.* If post-storm receiving water* quality has larger concentrations of constituents relative to pre-storm, and Table 3 instantaneous maximum concentrations for chemical constituents, and daily maximum concentrations for chronic toxicity,* are exceeded, then receiving water* shall be re-analyzed along with storm runoff (end of pipe) for the constituents that are exceeded.

(7) If undesirable alterations of natural water quality and/or biological communities are identified, control strategies/measures shall be implemented for those dischargers characterized as a high threat or those contributing to higher threat cumulative impacts first.

(8) If those strategies fail, additional control strategies/measures will be implemented for dischargers characterized as medium impact dischargers. If these strategies do not result in improvement of water quality, those discharges classified as low threat shall also implement control strategies/measures.

d. Implementation Provisions for New Discharges

(1) Point Source Wastewater Outfalls

No new point source wastewater outfalls shall be established within an SWQPA-GP.

(2) Seawater* intakes

* See Appendix I for definition of terms.

No new surface water seawater* intakes shall be established within an SWQPA-GP. This does not apply to subsurface* intakes where studies are prepared showing there is no predictable entrainment, impingement, or construction-related marine life mortality.

(3) All Other New Discharges

There shall be no increase in nonpoint sources or permitted storm drains directly into an SWQPA-GP.

2. Impaired Tributaries to MPAs, SWQPA-ASBS and SWQPA-GP

All water bodies draining to, or that are designated as, MPAs and SWQPAs that appear on the State's CWA section 303(d) list shall be given a high priority to have a TMDL developed and implemented.

F. Revision of Waste* Discharge Requirements

1. The Regional Water Boards may establish more restrictive water quality objectives and effluent limitations than those set forth in this Plan as necessary for the protection of beneficial uses of ocean* waters.

2. Regional Water Boards may impose alternative less restrictive provisions than those contained within Table 3 of the Plan, provided an applicant can demonstrate that:

   a. Reasonable control technologies (including source control, material* substitution, treatment and dispersion) will not provide for complete compliance; or

   b. Any less stringent provisions would encourage water* reclamation;

3. Provided further that:

   a. Any alternative water quality objectives shall be below the conservative estimate of chronic toxicity,* as given in Table 4 (with all metal concentrations expressed as total recoverable concentrations), and such alternative will provide for adequate protection of the marine environment;

   b. A receiving water* quality toxicity objective of 1 TUc is not exceeded; and

   c. The State Water Board grants an exception (chapter III.J) to the Table 3 limits as established in the Regional Board findings and alternative limits.

* See Appendix I for definition of terms.

G. Compliance Schedules in National Pollutant Discharge Elimination System (NPDES) Permits

1. Compliance schedules in NPDES permits are authorized in accordance with the provisions of the State Water Board's Policy for Compliance Schedules in [NPDES] Permits (2008).

Table 6 (formerly Table D): Conservative Estimates of Chronic* Toxicity

Constituent	**Estimate of Chronic* Toxicity (µg/L)**
Arsenic	19.
Cadmium	8.
Hexavalent Chromium	18.
Copper	5.
Lead	22.
Mercury	0.4
Nickel	48.
Silver	3.
Zinc	51.
Cyanide	10.
Total Chlorine Residual	10.0
Ammonia	4000.0
Phenolic Compounds (non-chlorinated)	a) (see below)
Chlorinated Phenolics	a)
Chlorinated Pesticides and PCBs*	b)

Table 6 Notes:

a) There are insufficient data for phenolics to estimate chronic* toxicity levels. Requests for modification of water quality objectives for these waste* constituents must be supported by chronic* toxicity data for representative sensitive species. In such cases, applicants seeking modification of water quality objectives should consult the Regional Water Quality Control Board to determine the species and test conditions necessary to evaluate chronic effects.

b) Limitations on chlorinated pesticides and PCBs* shall not be modified so that the total of these compounds is increased above the objectives in Table 3.

H. Monitoring Program

1. The Regional Water Boards shall require dischargers to conduct self-monitoring programs and submit reports necessary to determine compliance with the

* See Appendix I for definition of terms.

waste* discharge requirements, and may require dischargers to contract with agencies or persons acceptable to the Regional Water Board to provide monitoring reports. Monitoring provisions contained in waste* discharge requirements shall be in accordance with the Monitoring Procedures provided in Appendices III and VI.

2. The Regional Water Board may require monitoring of bioaccumulation of toxicants in the discharge zone. Organisms and techniques for such monitoring shall be chosen by the Regional Water Board on the basis of demonstrated value in waste* discharge monitoring.

I. Discharge Prohibitions

1. Hazardous Substances

   a. The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste* into the ocean* is prohibited.

2. Areas Designated for Special Water Quality Protection

   a. Waste* shall not be discharged to designated Areas* of Special Biological Significance except as provided in chapter III.E Implementation Provisions for Marine Managed Areas.*

3. Sludge

   a. Pipeline discharge of sludge to the ocean* is prohibited by federal law; the discharge of municipal and industrial waste* sludge directly to the ocean,* or into a waste* stream that discharges to the ocean,* is prohibited by this Plan. The discharge of sludge digester supernatant directly to the ocean,* or to a waste* stream that discharges to the ocean* without further treatment, is prohibited.

   b. It is the policy of the State Water Board that the treatment, use and disposal of sewage sludge shall be carried out in the manner found to have the least adverse impact on the total natural and human environment. Therefore, if federal law is amended to permit such discharge, which could affect California waters, the State Water Board may consider requests for exceptions to this section under Chapter III.J of this Plan, provided further that an Environmental Impact Report on the proposed project shows clearly that any available alternative disposal method will have a greater adverse environmental impact than the proposed project.

4. By-Passing

   a. The by-passing of untreated wastes* containing concentrations of pollutants in excess of those of Table 4 or Table 3 to the ocean* is prohibited.

* See Appendix I for definition of terms.

5. Vessels

   a. Discharges of hazardous waste (as defined in California Health and Safety Code § 25117 et seq. [but not including sewage]), oily bilge water,* medical waste (as defined in § 117600 et seq. of the California Health and Safety Code) dry-cleaning waste, and film-processing waste from large passenger vessels* and oceangoing vessels* are prohibited.

   b. Discharges of graywater* and sewage* from large passenger vessels* are prohibited.

   c. Discharges of sewage and sewage sludge from vessels are prohibited in No Discharge Zones* promulgated by U.S. EPA.

6. Trash*

   The discharge of Trash* to surface waters of the State or the deposition of Trash* where it may be discharged into surface waters of the State is prohibited. Compliance with this prohibition of discharge shall be achieved as follows:

   a. Dischargers with NPDES permits that contain specific requirements for the control of Trash* that are consistent with these Trash Provisions* shall be determined to be in compliance with this prohibition if the dischargers are in full compliance with such requirements.

   b. Dischargers with non-NPDES waste discharge requirements (WDRs) or waivers of WDRs that contain specific requirements for the control of Trash* shall be determined to be in compliance with this prohibition if the dischargers are in full compliance with such requirements.

   c. Dischargers with NPDES permits, WDRs, or waivers of WDRs that do not contain specific requirements for the control of Trash* are exempt from these Trash Provisions*.

   d. Dischargers without NPDES permits, WDRs, or waivers of WDRs must comply with this prohibition of discharge.

   e. Chapter III.I.6.b and Chapter III.L.3 notwithstanding, this prohibition of discharge applies to the discharge of preproduction plastic* by manufacturers of preproduction plastics*, transporters of preproduction plastics*, and manufacturers that use preproduction plastics* in the manufacture of other products to surface waters of the State, or the deposition of preproduction plastic* where it may be discharged into surface waters of the State, unless the discharger is subject to a NPDES permit for discharges of storm water* associated with industrial activity.

* See Appendix I for definition of terms.

J. State Board Exceptions to Plan Requirements

1. The State Water Board may, in compliance with the California Environmental Quality Act, subsequent to a public hearing, and with the concurrence of the Environmental Protection Agency, grant exceptions where the Board determines:

    a. The exception will not compromise protection of ocean* waters for beneficial uses, and,

    b. The public interest will be served.

2. All exceptions issued by the State Water Board and in effect at the time of the Triennial Review will be reviewed at that time. If there is sufficient cause to re-open or revoke any exception, the State Water Board may direct staff to prepare a report and to schedule a public hearing. If after the public hearing the State Water Board decides to re-open, revoke, or re-issue a particular exception, it may do so at that time.

K. Implementation Provisions for Vessel Discharges

1. Vessel discharges must comply with State Lands Commission (SLC) requirements for ballast water discharges and hull fouling to control and prevent the introduction of non-indigenous species, found in the Public Resources Code sections 71200 et seq. and title 2, California Code of Regulations, section 22700 et. seq.

2. Discharges incidental to the normal operation large passenger vessels* and ocean- going vessels must be covered and comply with an individual or general NPDES permit.

3. Vessel discharges must not result in violations of water quality objectives in this plan.

4. Vessels subject to the federal NPDES Vessel General Permit (VGP) which are not large passenger vessels* must follow the best management practices for graywater* as required in the VGP, including the use of only those cleaning agents (e.g., soaps and detergents) that are phosphate-free, non-toxic, and non-bioaccumulative.

L. Implementation Provisions for Trash* [effective January 12, 2016 (only Section L)]

1. Applicability

    a. These Trash Provisions* shall be implemented through a prohibition of discharge (Chapter III.I.6) and through NPDES permits issued pursuant to section 402(p) of the Federal Clean Water Act, waste discharge

* See Appendix I for definition of terms.

requirements (WDRs), or waivers of WDRs (as set forth in Chapter III.L.2 and Chapter III.L.3 below).

b. These Trash Provisions* apply to all surface waters of the State, with the exception of those waters within the jurisdiction of the Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) for which trash Total Maximum Daily Loads (TMDLs) are in effect prior to the effective date of these Trash Provisions*[1]; provided, however, that:

(1) Upon the effective date of these Trash Provisions*, the Los Angeles Water Board shall cease its full capture system* certification process and provide that any new full capture systems* shall be certified by the State Water Board in accordance with these Trash Provisions*.

(2) Within one year of the effective date of these Trash Provisions*, the Los Angeles Water Board shall convene a public meeting to reconsider the scope of its trash TMDLs, with the exception of those for the Los Angeles River and Ballona Creek watersheds, to particularly consider an approach that would focus MS4* permittees' trash-control efforts on high-trash generation areas within their jurisdictions.

2. Dischargers Permitted Pursuant to Federal Clean Water Act Section 402(p)

Permitting authorities* shall include the following requirements in NPDES permits issued pursuant to Federal Clean Water Act section 402(p):

a. MS4* permittees with regulatory authority over priority land uses* shall be required to comply with the prohibition of discharge in Chapter III.I.6.a herein by either of the following measures:

(1) Track 1: Install, operate, and maintain full capture systems* for all storm drains that captures runoff from the priority land uses* in their jurisdictions; or

(2) Track 2: Install, operate, and maintain any combination of full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* within either the jurisdiction of the MS4* permittee or within the jurisdiction of the MS4* permittee and contiguous MS4*

[1] In the Los Angeles Region, there are fifteen (15) trash TMDLs for the following watersheds and water bodies: Los Angeles River Watershed, Ballona Creek, Malibu Creek Watershed, Santa Monica Bay Nearshore and Offshore, San Gabriel River East Fork, Revolon Slough and Beardsley Wash, Ventura River Estuary, Machado Lake, Lake Elizabeth, Lake Hughes, Munz Lake, Peck Road Park Lake, Echo Park Lake, Lincoln Park Lake and Legg Lake. Three of these were established by the U.S. EPA: Peck Road Park Lake, Echo Park Lake and Lincoln Park Lake.

* See Appendix I for definition of terms.

permittees. The MS4* permittee may determine the locations or land uses within its jurisdiction to implement any combination of controls. The MS4* permittee shall demonstrate that such combination achieves full capture system equivalency*. The MS4* permittee may determine which controls to implement to achieve compliance with full capture system equivalency*. It is, however, the State Water Board's expectation that the MS4* permittee will elect to install full capture systems* where such installation is not cost-prohibitive.

b. The California Department of Transportation (Department) shall be required to comply with the prohibition of discharge in Chapter III.I.6.a herein in all significant trash generating areas* by installing, operating, and maintaining any combination of full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* for all storm drains that captures runoff from significant trash generating areas*. The Department shall demonstrate that such combination achieves full capture system equivalency*. In furtherance of this provision, the Department and MS4* permittees that are subject to the provisions of Chapter III.L.2.a herein shall coordinate their efforts to install, operate, and maintain full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* in significant trash generating areas* and/or priority land uses*.

c. Dischargers that are subject to NPDES permits for discharges of storm water* associated with industrial activity (including construction activity) shall be required to comply with the prohibition of discharge in Chapter III.I.6.a herein by eliminating Trash* from all storm water* and authorized non-storm water* discharges consistent with an outright prohibition of the discharge of Trash* contained within the applicable NPDES permit regulating the industrial or construction facility. If the discharger can satisfactorily demonstrate to the permitting authority* its inability to comply with the outright prohibition of the discharge of Trash* contained within the applicable NPDES permit, then the permitting authority* may require the discharger to either:

(1) Install, operate, and maintain full capture systems* for all storm drains that captures runoff from the facility or site regulated by the NPDES permit; or,

(2) Install, operate, and maintain any combination of full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* for the facility or site regulated by the NPDES permit. The discharger shall demonstrate that such combination achieves full capture system equivalency*.

Termination of permit coverage for industrial and construction storm water* dischargers shall be conditioned upon the proper operation and maintenance

* See Appendix I for definition of terms.

of all controls (e.g., full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls*) used at their facility(ies).

d. A permitting authority* may determine that specific land uses or locations (e.g., parks, stadia, schools, campuses, or roads leading to landfills) generate substantial amounts of Trash*. In the event that the permitting authority* makes that determination, the permitting authority* may require the MS4* to comply with Chapter III.L.2.a.1 or Chapter III.L.2.a.2, as determined by the permitting authority*, with respect to such land uses or locations.

3. Other Dischargers

A permitting authority* may require dischargers, described in Chapter III.I.6.c or Chapter III.I.6.d, that are not subject to Chapter III.L.2 herein, to implement any appropriate Trash* controls in areas or facilities that may generate Trash*. Such areas or facilities may include (but are not limited to) high usage campgrounds, picnic areas, beach recreation areas, parks not subject to an MS4* permit, or marinas.

4. Time Schedule

The permitting authority* shall modify, re-issue, or newly adopt NPDES permits issued pursuant to section 402(p) of the Federal Clean Water Act that are subject to the provisions of Chapter III.L.2 herein to include requirements consistent with these Trash Provisions*. The permitting authorities* shall abide by the following time schedules:

a. NPDES Permits Regulating MS4* Permittees that have Regulatory Authority over Priority Land Uses*.[2]

[2] The time schedule requirement in Chapter III.L.4.a.1 requiring MS4* permittees to elect Chapter III.L.2.a.1 (Track 1) or Chapter III.L.2.a.2 (Track 2) does not apply to MS4* permittees subject to the Municipal Regional Stormwater NPDES Permit (MRP) issued by the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) or the East Contra Costa Municipal Storm Water Permit issued by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) because those permits already require control requirements substantially equivalent to Track 2. The time schedule requirement in Chapter III.L.4.a.1 requiring MS4* permittees to submit an implementation plan does not apply to the above permittees if the pertinent permitting authority* determines that such permittee has already submitted an implementation plan prior to the effective date of the Trash Provisions* that is equivalent to the implementation plan required by Chapter III.L.4.a.1. In the aforementioned permits, the pertinent permitting authority* may establish an earlier full compliance deadline than that specified in Chapter III.L.4.a.3.

* See Appendix I for definition of terms.

(1) Within eighteen (18) months of the effective date of these Trash Provisions*, for each permittee, each permitting authority* shall either:

A. Modify, re-issue, or adopt the applicable MS4* permit to add requirements to implement these Trash Provisions*. The implementing permit shall require written notice from each MS4* permittee stating whether it has elected to comply under Chapter III.L.2.a.1 (Track 1) or Chapter III.L.2.a.2 (Track 2) and such notice shall be submitted to the permitting authority* no later than three (3) months from the effective date of the implementing permit, or for MS4s* designated after the effective date of these Trash Provisions*, three (3) months from the effective date of that designation. The implementing permit shall also require that within eighteen (18) months of the effective date of the implementing permit or new designation, MS4* permittees that have elected to comply with Track 2 shall submit an implementation plan to the permitting authority*. The implementation plan shall describe: (i) the combination of controls selected by the MS4* permittee and the rationale for the selection, (ii) how the combination of controls is designed to achieve full capture system equivalency*, and (iii) how full capture system equivalency* will be demonstrated. The implementation plan is subject to approval by the permitting authority*.

B. Issue an order pursuant to Water Code section 13267 or 13383 requiring the MS4* permittee to submit, within three (3) months from receipt of the order, written notice to the permitting authority* stating whether such MS4* permittee will comply with the prohibition of discharge under Chapter III.L.2.a.1 (Track 1) or Chapter III.L.2.a.2 (Track 2). For MS4s* designated after the effective date of these Trash Provisions*, the order pursuant to Water Code section 13267 or 13383 shall be issued at the time of designation. Within eighteen (18) months of the receipt of the Water Code section 13267 or 13383 order, MS4* permittees that have elected to comply with Track 2 shall submit an implementation plan to the permitting authority* that describes: (i) the combination of controls selected by the MS4* permittee and the rationale for the selection, (ii) how the combination of controls is designed to achieve full capture system equivalency*, and (iii) how full capture system equivalency* will be demonstrated. The implementation plan is subject to approval by the permitting authority*.

(2) For MS4* permittees that elect to comply with Chapter III.L.2.a.1 (Track1), the implementing permit shall state that full compliance shall occur within ten (10) years of the effective date of the first implementing permit except as specified in Chapter III.L.4.a.5. The permit shall also

* See Appendix I for definition of terms.

require these permittees to demonstrate achievement of interim milestones such as average load reductions of ten percent (10%) per year or other progress to full implementation. In no case may the final compliance date be later than fifteen (15) years from the effective date of these Trash Provisions*.

(3) For MS4* permittees that elect to comply with Chapter III.L.2.a.2 (Track 2), the implementing permit shall state that full compliance shall occur within ten (10) years of the effective date of the first implementing permit except as specified in Chapter III.L.4.a.5. The permit shall also require these permittees to demonstrate achievement of interim milestones such as average load reductions of ten percent (10%) per year or other progress to full implementation. In no case may the final compliance date be later than fifteen (15) years from the effective date of these Trash Provisions*.

(4) The implementing permit shall state that for MS4* permittees designated after the effective date of the implementing permit, full compliance shall occur within ten (10) years of the effective date of the designation. The permit shall also require such designations to demonstrate achievement of interim milestones such as average load reductions of ten percent (10%) per year or other progress to full implementation.

(5) Where a permitting authority* makes a determination pursuant to Chapter III.L.2.d that a specific land use generates a substantial amount of Trash*, that permitting authority* has discretion to determine the time schedule for full compliance. In no case may the final compliance date be later than ten (10) years from the determination.

b. NPDES Permits Regulating the Department.

(1) Within eighteen (18) months of the effective date of these Trash Provisions*, the State Water Board shall issue an order pursuant to Water Code section 13267 or 13383 requiring the Department to submit an implementation plan to the Executive Director of the State Water Board that: (i) describes the specific locations of its significant trash generating areas*, (ii) the combination of controls selected by the Department and the rationale for the selections, and (iii) how it will demonstrate full capture system equivalency*.

(2) The Department must demonstrate full compliance with Chapter III.L.2.b herein within ten (10) years of the effective date of the first implementing NPDES permit, along with achievements of interim milestones such as average load reductions of ten percent (10%) per year. In no case may the final compliance date be later than fifteen (15) years from the effective date of these Trash Provisions*.

* See Appendix I for definition of terms.

c. NPDES Permits Regulating the Discharges of Storm Water* Associated with Industrial Activity (Including Construction Activity). Dischargers that are subject to the provisions of Chapter III.L.2.c herein must demonstrate full compliance in accordance with the deadlines contained in the first implementing NPDES permits. Such deadlines may not exceed the terms of the first implementing permits.

5. Monitoring and Reporting

The permitting authority* must include monitoring and reporting requirements in its implementing permits. The following monitoring and reporting provisions are the minimum requirements that must be included within the implementing permits:

a. MS4* permittees that elect to comply with Chapter III.L.2.a.1 (Track 1) shall provide a report to the applicable permitting authority* demonstrating installation, operation, maintenance, and the Geographic Information System- (GIS-) mapped location and drainage area served by its full capture systems* on an annual basis.

b. MS4* permittees that elect to comply with Chapter III.L.2.b.2 (Track 2) shall develop and implement monitoring plans that demonstrate the effectiveness of the full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* and compliance with full capture system equivalency*. Monitoring reports shall be provided to the applicable permitting authority* on an annual basis, and shall include GIS-mapped locations and drainage area served for each of the full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* installed or utilized by the MS4* permittee. In developing the monitoring reports the MS4* permittee should consider the following questions:

(1) What type of and how many treatment controls*, institutional controls*, and/or multi-benefit projects* have been used and in what locations?

(2) How many full capture systems* have been installed (if any), in what locations have they been installed, and what is the individual and cumulative area served by them?

(3) What is the effectiveness of the total combination of treatment controls*, institutional controls*, and multi-benefit projects* employed by the MS4* permittee?

(4) Has the amount of Trash* discharged from the MS4* decreased from the previous year? If so, by how much? If not, explain why.

(5) Has the amount of Trash* in the MS4's* receiving water(s) decreased from the previous year? If so, by how much? If not, explain why.

* See Appendix I for definition of terms.

c. The Department, as subject to the provisions of Chapter III.L.2.b, shall develop and implement monitoring plans that demonstrate the effectiveness of the controls and compliance with full capture system equivalency*. Monitoring reports shall be provided to the State Water Board on an annual basis, and shall include GIS-mapped locations and drainage area served for each of the full capture systems*, multi-benefit projects*, other treatment controls*, and/or institutional controls* installed or utilized by the Department. In developing the monitoring report, the Department should consider the following questions:

(1) What type of and how many treatment controls* institutional controls*, and/or multi-benefit projects* have been used and in what locations?

(2) How many full capture systems* have been installed (if any), in what locations have they been installed, and what is the individual and cumulative area served by them?

(3) What is the effectiveness of the total combination of treatment controls*, institutional controls*, and multi-benefit projects* employed by the Department?

(4) Has the amount of Trash* discharged from the Department's MS4* decreased from the previous year? If so, by how much? If not, explain why.

(5) Has the amount of Trash* in the receiving waters decreased from the previous year? If so, by how much? If not, explain why.

d. Dischargers that are subject to the provisions of Chapter III.L.2.c herein shall be required to report the measures used to comply with Chapter III.L.2.c.

M. Implementation Provisions for Desalination Facilities*

1. Applicability and General Provisions

a. Chapter III.M applies to desalination facilities* using seawater.* Chapter III.M.2 does not apply to desalination facilities* operated by a federal agency. Chapter III.M.2, M.3, and M.4 do not apply to portable desalination facilities* that withdraw less than 0.10 million gallons per day (MGD) of seawater* and are operated by a governmental agency. These standards do not alter or limit in any way the authority of any public agency to implement its statutory obligations. The Executive Director of the State Water Board may temporarily waive the application of chapter III.M to desalination facilities* that are operating to serve as a critical short-term water supply during a state of emergency as declared by the Governor.

b. Definitions of New, Expanded, and Existing Facilities:

* See Appendix I for definition of terms.

(1) For purposes of chapter III.M, “existing facilities” means desalination facilities* that have been issued an NPDES permit and all building permits and other governmental approvals necessary to commence construction for which the owner or operator has relied in good faith on those previously-issued permits and approvals and commenced construction of the facility beyond site grading prior to January 28, 2016.

(2) For purposes of chapter III.M, “expanded facilities” means existing facilities for which, after January 28, 2016, the owner or operator does either of the following in a manner that could increase intake or mortality of all forms of marine life * beyond that which was originally approved in any NPDES permit or Water Code section 13142.5, subdivision (b) (hereafter Water Code section 13142.5(b)) determination: 1) increases the amount of seawater* used either exclusively by the facility or used by the facility in conjunction with other facilities or uses, or 2) changes the design or operation of the facility. To the extent that the desalination facility* is co-located with another facility that withdraws water for a different purpose and that other facility reduces the volume of water withdrawn to a level less than the desalination facility’s* volume of water withdrawn, the desalination facility* is considered to be an expanded facility.

(3) For purposes of chapter III.M, “new facilities” means desalination facilities* that are not existing facilities or expanded facilities.

c. Chapter III.M.2 (Water Code §13142.5(b) Determinations for New and Expanded Facilities: Site, Design, Technology, and Mitigation Measures) applies to new and expanded desalination facilities* withdrawing seawater.*

d. Chapter III.M.3 (Receiving Water Limitation for Salinity*) applies to all desalination facilities* that discharge into ocean waters* and wastewater facilities that receive brine* from seawater* desalination facilities* and discharge into ocean waters.*

e. Chapter III.M.4 (Monitoring and Reporting Programs) applies to all desalination facilities* that discharge into ocean waters.* Chapter III.M.4 shall not apply to a wastewater facility that receives brine* from a seawater* desalination facility* and discharges a positively buoyant commingled effluent through an existing wastewater outfall that is covered under an existing NPDES permit, as long as the owner or operator monitors for compliance with the receiving water limitation set forth in chapter III.M.3. For the purposes of chapter III.M.4, a positively buoyant commingled effluent shall mean that the commingled plume rises when it enters the receiving water body due to salinity* levels in the commingled discharge being lower than the natural background salinity.*

* See Appendix I for definition of terms.

f. References to the regional water board include the regional water board acting under delegated authority. For provisions that require consultation between regional water board and State Water Board staff, the regional water board shall notify and consult with the State Water Board staff prior to making a final determination on the item requiring consultation.

g. All desalination facilities must comply with all other applicable sections of the Ocean Plan.

2. Water Code section 13142.5(b) Determinations for New and Expanded Facilities: Site, Design, Technology, and Mitigation Measures Feasibility Considerations

   a. General Considerations

      (1) The owner or operator shall submit a request for a Water Code section 13142.5(b) determination to the appropriate regional water board as early as practicable. This request shall include sufficient information for the regional water board to conduct the analyses described below. The regional water board in consultation with the State Water Board staff may require an owner or operator to provide additional studies or information if needed, including any information necessary to identify and assess other potential sources of mortality to all forms of marine life. All studies and models are subject to the approval of the regional water board in consultation with State Water Board staff. The regional water board may require an owner or operator to hire a neutral third party entity to review studies and models and make recommendations to the regional water board.

      (2) The regional water board shall conduct a Water Code section 13142.5(b) analysis of all new and expanded desalination facilities.* A Water Code section 13142.5(b) analysis may include future expansions at the facility. The regional water board shall first analyze separately as independent considerations a range of feasible* alternatives for the best available site, the best available design, the best available technology, and the best available mitigation measures to minimize intake and mortality of all forms of marine life.* Then, the regional water board shall consider all four factors collectively and determine the best combination of feasible* alternatives to minimize intake and mortality of all forms of marine life.* The best combination of alternatives may not always include the best alternative under each individual factor because some alternatives may be mutually exclusive, redundant, or not feasible* in combination.

      (3) The regional water board's Water Code section 13142.5(b) analysis for expanded facilities may be limited to those expansions or other changes

* See Appendix I for definition of terms.

that result in the increased intake or mortality of all forms of marine life,* unless the regional water board determines that additional measures that minimize intake and mortality of all forms of marine life* are feasible* for the existing portions of the facility.

(4) In conducting the Water Code section 13142.5(b) determination, the regional water boards shall consult with other state agencies involved in the permitting of that facility, including, but not limited to: California Coastal Commission, California State Lands Commission, and California Department of Fish and Wildlife. The regional water board shall consider project-specific decisions made by other state agencies; however, the regional water board is not limited to project-specific requirements set forth by other agencies and may include additional requirements in a Water Code section 13142.5(b) determination.

(5) A regional water board may expressly condition a Water Code section 13142.5(b) determination based on the expectation of the occurrence of a future event. Such future events may include, but are not limited to, the permanent shutdown of a co-located power plant with intake structures shared with the desalination facility,* or a reduction in the volume of wastewater available for the dilution of brine.* The regional water board must make a new Water Code section 13142.5(b) determination if the foreseeable future event occurs.

(a) The owner or operator shall provide notice to the regional water board as soon as it becomes aware that the expected future event will occur, and shall submit a new request for a Water Code section 13142.5(b) determination to the regional water board at least one year prior to the event occurring. If the owner or operator does not become aware that the event will occur at least one year prior to the event occurring, the owner or operator shall submit the request as soon as possible.

(b) The regional water board may allow up to five years from the date of the event for the owner or operator to make modifications to the facility required by a new Water Code section 13142.5(b) determination, provided that the regional water board finds that 1) any water supply interruption resulting from the facility modifications requires additional time for water users to obtain a temporary replacement supply, or 2) such a compliance period is otherwise in the public interest and reasonably required for modification of the facility to comply with the determination.

(c) If the regional water board makes a Water Code section 13142.5(b) determination for a desalination facility* that will be co-located with a power plant, the regional water board shall condition its

* See Appendix I for definition of terms.

determination on the power plant remaining in compliance with the Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling.

b. Site is the general onshore and offshore location of a new or expanded facility. There may be multiple potential facility design configurations within any given site. The regional water board shall require that the owner or operator evaluate a reasonable range of nearby sites, including sites that would likely support subsurface intakes. For each potential site, in order to determine whether a proposed facility site is the best available site feasible* to minimize intake and mortality of all forms of marine life,* the regional water board shall require the owner or operator to:

(1) Consider whether subsurface intakes* are feasible.*

(2) Consider whether the identified need for desalinated* water is consistent with an applicable adopted urban water management plan prepared in accordance with Water Code section 10631, or if no urban water management plan is available, other water planning documents such as a county general plan or integrated regional water management plan.

(3) Analyze the feasibility of placing intake, discharge, and other facility infrastructure in a location that avoid impacts to sensitive habitats* and sensitive species.

(4) Analyze the direct and indirect effects on all forms of marine life* resulting from facility construction and operation, individually and in combination with potential anthropogenic effects on all forms of marine life* resulting from other past, present, and reasonably foreseeable future activities within the area affected by the facility.

(5) Analyze oceanographic geologic, hydrogeologic, and seafloor topographic conditions at the site, so that the siting of a facility, including the intakes and discharges, minimizes the intake and mortality of all forms of marine life.*

(6) Analyze the presence of existing discharge infrastructure, and the availability of wastewater to dilute the facility's brine* discharge.

(7) Ensure that the intake and discharge structures are not located within a MPA or SWQPA* with the exception of intake structures that do not have marine life mortality associated with the construction, operation, and maintenance of the intake structures (e.g. slant wells). Discharges shall be sited at a sufficient distance from a MPA or SWQPA* so that the salinity* within the boundaries of a MPA or SWQPA* does not exceed

* See Appendix I for definition of terms.

natural background salinity.* To the extent feasible,* surface intakes shall be sited so as to maximize the distance from a MPA or SWQPA.*

c. Design is the size, layout, form, and function of a facility, including the intake capacity and the configuration and type of infrastructure, including intake and outfall structures. The regional water board shall require that the owner or operator perform the following in determining whether a proposed facility design is the best available design feasible* to minimize intake and mortality of all forms of marine life:*

(1) For each potential site, analyze the potential design configurations of the intake, discharge, and other facility infrastructure to avoid impacts to sensitive habitats* and sensitive species.

(2) If the regional water board determines that subsurface intakes* are not feasible* and surface water intakes are proposed instead, analyze potential designs for those intakes in order to minimize the intake and mortality of all forms of marine life.*

(3) Design the outfall so that the brine mixing zone* does not encompass or otherwise adversely affect existing sensitive habitat.*

(4) Design the outfall so that discharges do not result in dense, negatively-buoyant plumes that result in adverse effects due to elevated salinity* or hypoxic conditions occurring outside the brine mixing zone.* An owner or operator must demonstrate that the outfall meets this requirement through plume modeling and/or field studies. Modeling and field studies shall be approved by the regional water board in consultation with State Water Board staff.

(5) Design outfall structures to minimize the suspension of benthic sediments.

d. Technology is the type of equipment, materials,* and methods that are used to construct and operate the design components of the desalination facility.* The regional water board shall apply the following considerations in determining whether a proposed technology is the best available technology feasible* to minimize intake and mortality of all forms of marine life:*

(1) Considerations for Intake Technology:

(a) Subject to chapter M.2.a.(2), the regional water board in consultation with State Water Board staff shall require subsurface intakes* unless it determines that subsurface intakes* are not feasible* based upon a comparative analysis of the factors listed below for surface and subsurface intakes.* A design capacity in excess of the need for desalinated* water as identified in chapter

* See Appendix I for definition of terms.

III.M.2.b.(2) shall not be used by itself to declare subsurface intakes* as not feasible.*

i. The regional water board shall consider the following factors in determining feasibility of subsurface intakes:* geotechnical data, hydrogeology, benthic topography, oceanographic conditions, presence of sensitive habitats,* presence of sensitive species, energy use for the entire facility; design constraints (engineering, constructability), and project life cycle cost. Project life cycle cost shall be determined by evaluating the total cost of planning, design, land acquisition, construction, operations, maintenance, mitigation, equipment replacement and disposal over the lifetime of the facility, in addition to the cost of decommissioning the facility. Subsurface intakes* shall not be determined to be economically infeasible solely because subsurface intakes* may be more expensive than surface intakes. Subsurface intakes* may be determined to be economically infeasible if the additional costs or lost profitability associated with subsurface intakes,* as compared to surface intakes, would render the desalination facility* not economically viable. In addition, the regional water board may evaluate other site- and facility-specific factors.

ii. If the regional water board determines that subsurface intakes* are not feasible* for the proposed intake design capacity, it shall determine whether subsurface intakes* are feasible* for a reasonable range of alternative intake design capacities. The regional water board may find that a combination of subsurface* and surface intakes is the best feasible* alternative to minimize intake and mortality of marine life and meet the identified need for desalinated water as described in chapter III.M.2.b.(2).

(b) Installation and maintenance of a subsurface intake* shall avoid, to the maximum extent feasible,* the disturbance of sensitive habitats* and sensitive species.

(c) If subsurface intakes* are not feasible,* the regional water board may approve a surface water intake, subject to the following conditions:

i. The regional water board shall require that surface water intakes be screened. Screens must be functional while the facility is withdrawing seawater.*

ii. In order to reduce entrainment, all surface water intakes must be screened with a 1.0 mm (0.04 in) or smaller slot size screen when the desalination facility* is withdrawing seawater.*

* See Appendix I for definition of terms.

iii. An owner or operator may use an alternative method of preventing entrainment so long as the alternative method results in intake and mortality of eggs, larvae, and juvenile organisms that is less than or equivalent to a 1.0 mm (0.04 in) slot size screen. The owner or operator must demonstrate the effectiveness of the alternative method to the regional water board. The owner or operator must conduct a study to demonstrate the effectiveness of the alternative method, and use an Empirical Transport Model* (ETM)/ Area of Production Forgone* (APF) approach* to estimate entrainment. The study period shall be at least 12 consecutive months. Sampling for environmental studies shall be designed to account for variation in oceanographic or hydrologic conditions and larval abundance and diversity such that abundance estimates are reasonably accurate. Samples must be collected using a mesh size no larger than 335 microns and individuals collected shall be identified to the lowest taxonomical level practicable. The ETM/APF analysis* shall evaluate entrainment for a broad range of species, species morphologies, and sizes under the environmental and operational conditions that are representative of the entrained species and the conditions at the full-scale desalination facility.* At their discretion, the regional water boards may permit the use of existing entrainment data to meet this requirement.

iv. In order to minimize impingement, through-screen velocity at the surface water intake shall not exceed 0.15 meters per second (0.5 feet per second).

(2) Considerations for Brine* Discharge Technology:

(a) The preferred technology for minimizing intake and mortality of all forms of marine life* resulting from brine* discharge is to commingle brine* with wastewater (e.g., agricultural, municipal, industrial, power plant cooling water, etc.) that would otherwise be discharged to the ocean. The wastewater must provide adequate dilution to ensure salinity* of the commingled discharge meets the receiving water limitation for salinity* in chapter III.M.3. Nothing in this section shall preclude future recycling of the wastewater.

(b) Multiport diffusers* are the next best method for disposing of brine* when the brine* cannot be diluted by wastewater and when there are no live organisms in the discharge. Multiport diffusers* shall be engineered to maximize dilution, minimize the size of the brine mixing zone,* minimize the suspension of benthic sediments, and minimize mortality of all forms of marine life.*

* See Appendix I for definition of terms.

(c) Brine* discharge technologies other than wastewater dilution and multiport diffusers,* may be used if an owner or operator can demonstrate to the regional water board that the technology provides a comparable level of intake and mortality of all forms of marine life* as wastewater dilution if wastewater is available, or multiport diffusers* if wastewater is unavailable. The owner or operator must evaluate all of the individual and cumulative effects of the proposed alternative discharge method on the intake and mortality of all forms of marine life,* including (where applicable); intake-related entrainment, osmotic stress, turbulence that occurs during water conveyance and mixing, and shearing stress at the point of discharge. When determining the intake and mortality associated with a brine* discharge technology or combination of technologies, the regional water board shall require the owner or operator to use empirical studies or modeling to:

i. Estimate intake entrainment impacts using an ETM/APF approach.*

ii. Estimate degradation of all forms of marine life* from elevated salinity* within the brine mixing zone,* including osmotic stresses, the size of impacted area, and the duration that all forms of marine life* are exposed to the toxic conditions. Considerations shall be given to the most sensitive species, and community structure and function.

iii. Estimate the intake and mortality of all forms of marine life* that occurs as a result of water conveyance, in-plant turbulence or mixing, and waste* discharge.

iv. Within 18 months of beginning operation, submit to the regional water board an empirical study that evaluates intake and mortality of all forms of marine life* associated with the alternative brine* discharge technology. The study must evaluate impacts caused by any augmented intake volume, intake and pump technology, water conveyance, waste brine* mixing, and effluent discharge. Unless demonstrated otherwise, organisms entrained by the alternative brine* discharge technology are assumed to have a mortality rate of 100 percent. The study period shall be at least 12 consecutive months. If the regional water board requires a study period longer than 12 months, the final report must be submitted to the regional water board within 6 months of the completion of the empirical study.

v. If the empirical study shows that the alternative brine* discharge technology results in more intake and mortality of all forms of

* See Appendix I for definition of terms.

marine life* than a facility using wastewater dilution or multiport diffusers,* then the facility must either: (1) cease using the alternative brine* discharge technology and install and use wastewater dilution or multiport diffusers* to discharge brine* waste, or (2) re-design the alternative brine* discharge technology system to minimize intake and mortality of all forms of marine life* to a level that is comparable with wastewater dilution if wastewater is available, or multiport diffusers* if wastewater is unavailable,* subject to regional water board approval.

(d) Flow augmentation* as an alternative brine* discharge technology is prohibited with the following exceptions:

i. At facilities that use subsurface intakes* to supply augmented flow water for dilution. Facilities that use subsurface intakes* to supply augmented flow water for dilution are exempt from the requirements of chapter III.M.2.d.(2)(c) if the facility meets the receiving water limitation for salinity* in chapter III.M.3.

ii. At a facility that has received a conditional Water Code section 13142.5(b) determination and is over 80 percent constructed by January 28, 2016. If the owner or operator of the facility proposes to use flow augmentation* as an alternative brine* discharge technology, the facility must: use low turbulence intakes (e.g., screw centrifugal pumps or axial flow pumps) and conveyance pipes; convey and mix dilution water in a manner that limits thermal stress, osmotic stress, turbulent shear stress, and other factors that could cause intake and mortality of all forms of marine life*; comply with chapter III.M.2.d.(1); and not discharge through multiport diffusers.*

e. Mitigation for the purposes of this section is the replacement of all forms of marine life* or habitat that is lost due to the construction and operation of a desalination facility* after minimizing intake and mortality of all forms of marine life* through best available site, design, and technology. The regional water board shall ensure an owner or operator fully mitigates for the operational lifetime of the facility and uses the best available mitigation measures feasible* to minimize intake and mortality of all forms of marine life.* The owner or operator may choose whether to satisfy a facility's mitigation measures pursuant to chapter III.M.2.e.(3) or, if available, M.2.e.(4), or a combination of the two.

(1) *Marine Life Mortality Report.* The owner or operator of a facility shall submit a report to the regional water board estimating the marine life mortality resulting from construction and operation of the facility after

* See Appendix I for definition of terms.

implementation of the facility's required site, design, and technology measures.

(a) For operational mortality related to intakes, the report shall include a detailed entrainment study. The entrainment study period shall be at least 12 consecutive months and sampling shall be designed to account for variation in oceanographic or hydrologic conditions and larval abundance and diversity such that abundance estimates are reasonably accurate. At their discretion, the regional water boards may permit the use of existing entrainment data from the facility to meet this requirement. Samples must be collected using a mesh size no larger than 335 microns and individuals collected shall be identified to the lowest taxonomical level practicable. The ETM/APF analysis* shall be representative of the entrained species collected using the 335 micron net. The APF* shall be calculated using a one-sided, upper 95 percent confidence bound for the 95th percentile of the APF distribution. An owner or operator with subsurface intakes* is not required to do an ETM/APF analysis* for their intakes and is not required to mitigate for intake-related operational mortality. The regional water board may apply a one percent reduction to the APF* acreage calculated in the Marine Life Mortality Report to account for the reduction in entrainment of all forms of marine life* when using a 1.0 mm slot size screen.

(b) For operational mortality related to discharges, the report shall estimate the area in which salinity* exceeds 2.0 parts per thousand above natural background salinity* or a facility-specific alternative receiving water limitation (see chapter III.M.3). The area in excess of the receiving water limitation for salinity* shall be determined by modeling and confirmed with monitoring. The report shall use any acceptable approach approved by the regional water board for evaluating mortality that occurs due to shearing stress resulting from the facility's discharge, including any incremental increase in mortality resulting from a commingled discharge.

(c) For construction-related mortality, the report shall use any acceptable approach approved by the regional water board for evaluating the mortality that occurs within the area disturbed by the facility's construction. The regional water board may determine that the construction-related disturbance does not require mitigation because the disturbance is temporary and the habitat is naturally restored.

(d) Upon approval of the report by the regional water board in consultation with State Water Board staff, the calculated marine life

* See Appendix I for definition of terms.

mortality shall form the basis for the mitigation provided pursuant to this section.

(2) The owner or operator shall mitigate for the mortality of all forms of marine life* determined in the report above by choosing to either complete a mitigation project as described in chapter III.M.2.e.(3) or, if an appropriate fee-based mitigation program is available, provide funding for the program as described in chapter III.M.2.e.(4). The mitigation project or the use of a fee-based mitigation program and the amount of the fee that the owner or operator must pay is subject to regional water board approval.

(3) *Mitigation Option 1: Complete a Mitigation Project.* The mitigation project must satisfy the following provisions:

(a) The owner or operator shall submit a Mitigation Plan. Mitigation Plans shall include: project objectives, site selection, site protection instrument (the legal arrangement or instrument that will be used to ensure the long-term protection of the compensatory mitigation project site), baseline site conditions, a mitigation work plan, a maintenance plan, a long-term management plan, an adaptive management plan, performance standards and success criteria, monitoring requirements, and financial assurances.

(b) The mitigation project must meet the following requirements:

i. Mitigation shall be accomplished through expansion, restoration or creation of one or more of the following: kelp beds,* estuaries,* coastal wetlands, natural reefs, MPAs, or other projects approved by the regional water board that will mitigate for intake and mortality of all forms of marine life* associated with the facility.

ii. The owner or operator shall demonstrate that the project fully mitigates for intake-related marine life mortality by including expansion, restoration, or creation of habitat based on the APF* acreage calculated in the Marine Life Mortality Report above. The owner or operator using surface water intakes shall do modeling to evaluate the areal extent of the mitigation project's production area to confirm that it overlaps the facility's source water body.* Impacts on the mitigation project due to entrainment by the facility must be offset by adding compensatory acreage to the mitigation project.

* See Appendix I for definition of terms.

iii. The owner or operator shall demonstrate that the project also fully mitigates for the discharge-related marine life mortality projected in the Marine Life Mortality Report above.

iv. The owner or operator shall demonstrate that the project also fully mitigates for the construction-related marine life mortality identified in the Marine Life Mortality Report above.

v. The regional water board may permit out-of-kind mitigation* for mitigation of open water or soft-bottom species. In-kind mitigation* shall be done for all other species whenever feasible.*

vi. For out-of-kind mitigation,* an owner or operator shall evaluate the biological productivity of the impacted open water or soft-bottom habitat calculated in the Marine Life Mortality Report and the proposed mitigation habitat. If the mitigation habitat is a more biologically productive habitat (e.g. wetlands, estuaries,* rocky reefs, kelp beds,* eelgrass beds,* surfgrass beds*), the regional water boards may apply a mitigation ratio based on the relative biological productivity of the impacted open water or soft-bottom habitat and the mitigation habitat. The mitigation ratio shall not be less than one acre of mitigation habitat for every ten acres of impacted open water or soft-bottom habitat.

vii. For in-kind mitigation,* the mitigation ratio shall not be less than one acre of mitigation habitat for every one acre of impacted habitat.

viii. For both in-kind* and out-of-kind mitigation,* the regional water boards may increase the required mitigation ratio for any species and impacted natural habitat calculated in the Marine Life Mortality Report when appropriate to account for imprecisions associated with mitigation including, but not limited to, the likelihood of success, temporal delays in productivity, and the difficulty of restoring or establishing the desired productivity functions.

ix. The rationale for the mitigation ratios must be documented in the administrative record for the permit action.

(c) The Mitigation Plan is subject to approval by the regional water board in consultation with State Water Board staff and with other agencies having authority to condition approval of the project and require mitigation.

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* See Appendix I for definition of terms.

(4) *Mitigation Option 2: Fee-based Mitigation Program*. If the regional water board determines that an appropriate fee-based mitigation program has been established by a public agency, and that payment of a fee to the mitigation program will result in the creation and ongoing implementation of a mitigation project that meets the requirements of chapter M.2.e.(3), the owner or operator may pay a fee to the mitigation program in lieu of completing a mitigation project.

(a) The agency that manages the fee-based mitigation program must have legal and budgetary authority to accept and spend mitigation funds, a history of successful mitigation projects documented by having set and met performance standards for past projects, and stable financial backing in order to manage mitigation sites for the operational life of the facility.

(b) The amount of the fee shall be based on the cost of the mitigation project, or if the project is designed to mitigate cumulative impacts from multiple desalination facilities or other development projects, the amount of the fee shall be based on the desalination facility's* fair share of the cost of the mitigation project.

(c) The manager of the fee-based mitigation program must consult with the California Department of Fish and Wildlife, Ocean Protection Council, Coastal Commission, State Lands Commission, and State and regional water boards to develop mitigation projects that will best compensate for intake and mortality of all forms of marine life* caused by the desalination facility.* Mitigation projects that increase or enhance the viability and sustainability of all forms of marine life* in Marine Protected Areas are preferred, if feasible.*

(5) California Department of Fish and Wildlife, the regional water board, and State Water Board may perform audits or site inspections of any mitigation project.

(6) An owner or operator, or a manager of a fee-based mitigation program, must submit a mitigation project performance report to the regional water board 180 days prior to the expiration date of their NPDES permit.

(7) For conditionally permitted facilities or expanded facilities, the regional water boards may:

(a) Account for previously-approved mitigation projects associated with a facility when making a new Water Code section 13142.5(b) determination.

* See Appendix I for definition of terms.

(b) Require additional mitigation when making a new Water Code section 13142.5(b) determination for any additional mortality of all forms of marine life resulting from the occurrence of the conditional event or the expansion of the facility. The additional mitigation must be to compensate for any additional construction, discharge, or other increases in intake or impacts or an increase in intake and mortality of all forms of marine life.*

3. Receiving Water Limitation for Salinity*

a. Chapter III.M.3 is applicable to all desalination facilities discharging brine* into ocean waters,* including facilities that commingle brine* and wastewater.

b. The receiving water limitation for salinity* shall be established as described below:

(1) Discharges shall not exceed a daily maximum of 2.0 parts per thousand (ppt) above natural background salinity* measured no further than 100 meters (328 ft) horizontally from each discharge point. There is no vertical limit to this zone.

(2) In determining an effluent limit necessary to meet this receiving water limitation, permit writers shall use the formula in chapter III.C.4 that has been modified for brine* discharges as follows:

Equation 1: Ce= Co + Dm(2.0 ppt)
Ce= (2.0 ppt + Cs) + Dm(2.0 ppt)

Where:

Ce= the effluent concentration limit, ppt
Co= the salinity* concentration to be met at the completion of initial* dilution= 2.0 ppt + Cs
Cs= the natural background salinity,* ppt
Dm= minimum probable initial dilution* expressed as parts seawater* per part brine* discharge

(a) The fixed distance referenced in the initial dilution* definition shall be no more than 100 meters (328 feet).

(b) In addition, the owner or operator shall develop a dilution factor (Dm) based on the distance of 100 meters (328 feet) or initial dilution,* whichever is smaller. The dilution factor (Dm) shall be developed within the brine mixing zone* using applicable water quality models that have been approved by the regional water boards in consultation with State Water Board staff.

* See Appendix I for definition of terms.

(c) The value 2.0 ppt in Equation 1 is the maximum incremental increase above natural background salinity* (Cs) allowed at the edge of the brine mixing zone.* A regional water board may substitute an alternative numeric value for 2.0 ppt in Equation 1 based upon the results of a facility-specific alternative salinity* receiving water limitation study, as described in chapter III.M.3.c below.

c. An owner or operator may submit a proposal to the regional water board for approval of an alternative (other than 2 ppt) salinity* receiving water limitation to be met no further than 100 meters horizontally from the discharge. There is no vertical limit to this zone.

(1) To determine whether a proposed facility-specific alternative receiving water limitation is adequately protective of beneficial uses, an owner or operator shall:

(a) Establish baseline biological conditions at the discharge location and at reference locations over a 12-month period prior to commencing brine* discharge. The biologic surveys must characterize the ecologic composition of habitat and marine life using measures established by the regional water board. At their discretion, the regional water boards may permit the use of existing data to meet this requirement.

(b) Conduct at least the following chronic toxicity* Whole Effluent Toxicity (WET) tests: germination and growth for giant kelp (*Macrocystis pyrifera)*; development for red abalone (*Haliotis refescens)*; development and fertilization for purple urchin (*Strongleocentrotus purpuratus)*; development and fertilization for sand dollar (*Dendraster excentricus)*; larval growth rate for topsmelt (*Atherniops affinis)*. WET tests shall be performed by an Environmental Laboratory Accreditation Program (ELAP) certified laboratory.

(c) The regional water board in consultation with State Water Board staff may require an owner or operator to do additional toxicity studies if needed.

(2) The regional water board in consultation with the State Water Board staff may require an owner or operator to provide additional studies or information in order to approve a facility-specific alternative receiving water limitation for salinity.*

(3) The facility-specific alternative receiving water limitation shall be based on the lowest observed effect concentration (LOEC)* for the most

* See Appendix I for definition of terms.

sensitive species and toxicity endpoint as determined in the chronic toxicity* studies. The regional water board in consultation with State Water Board staff has discretion to approve the proposed facility-specific alternative receiving water limitation for salinity.*

(4) The regional water board shall review a facility's monitoring data, the studies as required in chapter III.M.4 below, or any other information that the regional water board deems to be relevant to periodically assess whether the facility-specific alternative receiving water limitation for salinity* is adequately protective of beneficial uses. The regional water board may eliminate or revise a facility-specific alternative receiving water limitation for salinity* based on its assessment of the data.

d. The owner or operator of a facility that has received a conditional Water Code section 13142.5(b) determination and is over 80 percent constructed by January 28, 2016 that proposes flow augmentation* using a surface water intake may submit a proposal to the regional water board in consultation with the State Water Board staff for approval of an alternative brine mixing zone* not to exceed 200 meters laterally from the discharge point and throughout the water column. The owner or operator of such a facility must demonstrate, in accordance with chapter III.M.2.d.(2)(c), that the combination of the alternative brine mixing zone* and flow augmentation* using a surface water intake provide a comparable level of intake and mortality of all forms of marine life* as the combination of the standard brine mixing zone* and wastewater dilution if wastewater is available, or multiport diffusers* if wastewater is unavailable. In addition to the analysis of the effects required by chapter III.M.2.d.(2)(c), the owner or operator must also evaluate the individual and cumulative effects of the alternative brine mixing zone* on the intake and mortality of all forms of marine life.* In no case may the discharge result in hypoxic conditions outside of the alternative brine mixing zone.* If an alternative brine mixing zone* is approved, the alternative distance and the areal extent of the alternative brine mixing zone* shall be used in lieu of the standard brine mixing zone* for all purposes, including establishing an effluent limitation and a receiving water limitation for salinity, in chapter III.M.

e. Existing facilities that do not meet the receiving water limitation at the edge of the brine mixing zone* and throughout the water column by January 28, 2016 must either: 1) establish a facility-specific alternative receiving water limitation for salinity* as described in chapter III.M.3.c; or, 2) upgrade the facility's brine* discharge method in order to meet the receiving watr limitation in chapter III.M.3.b in accordance with the State Water Board's Compliance Schedule Policy, as set forth in chapter III.M.3.f below. An owner or operator that chooses to upgrade the facility's method of brine* discharge:

* See Appendix I for definition of terms.

(1) Must demonstrate to the regional water board that the brine* discharge does not negatively impact sensitive habitats,* sensitive species, MPAs, or SWQPAs.*

(2) Is subject to the Considerations for Brine* Discharge Technology described in chapter III.M.2.d.(2).

f. The regional water board may grant compliance schedules for the requirements for brine* waste discharges for desalination facilities.* All compliance schedules shall be in accordance with the State Water Board's Compliance Schedule Policy, except that the salinity* receiving water limitation set forth in chapters III.M.3.b and III.M.3.c shall be considered to be a "new water quality objective" as used in the Compliance Schedule Policy.

g. The regional water board in consultation with the State Water Board staff may require an owner or operator to provide additional studies or information if needed. All studies and models are subject to the approval of the regional water board in consultation with State Water Board staff. The regional water board may require an owner or operator to hire a neutral third party entity to review studies and models and make recommendations to the regional water board.

4. Monitoring and Reporting Programs

a. The owner or operator of a desalination facility* must submit a Monitoring and Reporting Plan to the regional water board for approval. The Monitoring and Reporting Plan shall include monitoring of effluent and receiving water characteristics and impacts to all forms of marine life.* The Monitoring and Reporting Plan shall, at a minimum, include monitoring for benthic community health, aquatic life toxicity, hypoxia, and receiving water characteristics consistent with Appendix III of this Plan and for compliance with the receiving water limitation in chapter III.M.3. Receiving water monitoring for salinity* shall be conducted at times when the monitoring locations are most likely affected by the discharge. For new or expanded facilities the following additional requirements apply:

(1) An owner or operator must perform facility-specific monitoring to demonstrate compliance with the receiving water limitation for salinity,* and evaluate the potential effects of the discharge within the water column, bottom sediments, and the benthic communities. Facility-specific monitoring is required until the regional water board determines that a regional monitoring program is adequate to ensure compliance with the receiving water limitation. The monitoring and reporting plan shall be reviewed, and revised if necessary, upon NPDES permit renewal.

* See Appendix I for definition of terms.

(2) Baseline biological conditions shall be established at the discharge location and at a reference location prior to commencement of construction. The owner or operator is required to conduct biological surveys (e.g., Before-After Control-Impact study), that will evaluate the differences between biological communities at a reference site and at the discharge location before and after the discharge commences. The regional water board will use the data and results from the surveys and any other applicable data for evaluating and renewing the requirements set forth in a facility's NPDES permit.

N. Water Quality Standards Variance

Federal regulations establish an explicit regulatory framework for the adoption of a water quality standards variance (WQS Variance*) that states may use to implement adaptive management approaches to improve water quality (40 C.F.R. § 131.14 (herein referred to as the federal rule)). The State Water Board and Regional Water Boards are not required to adopt specific authorizing provisions into state law before establishing a WQS Variance* consistent with the federal rule. The following explains the existing requirements that a water board must follow to establish a WQS Variance* consistent with the federal rule.

Under the federal rule, a WQS Variance* may be adopted for one or more NPDES dischargers or for a water body or waterbody segment, but the WQS Variance* only applies to the discharger(s) or the water body or waterbody segment specified in the WQS Variance*.

The federal rule specifies that any WQS Variance* is not effective unless and until it is approved by U.S. EPA. The federal rule also specifies that a WQS Variance* is subject to the public participation requirements at 40 Code of Federal Regulations section 131.20(b), which requires that one or more public hearings be held in accordance with state law and U.S. EPA's public participation regulation (40 C.F.R. part 25).

Where a discharger-specific WQS Variance* is established by a single permit, including an individual permit or a general permit, or other order, the federal rule's public participation requirements must be satisfied, and the provisions in the permit or other order that rely upon the discharger-specific WQS Variance* must be conditioned upon U.S. EPA approval. Because the establishment of a discharger-specific WQS Variance* in such a permit or other order is not the establishment or revision of a rule, the permit action need not be accompanied by a rulemaking action. The applicable hearing requirement for any other WQS Variance* would be subject to the hearing requirement and other procedures applicable to revising a water quality control plan, which are consistent with the federal rule's public participation requirements.

* See Appendix I for definition of terms.

APPENDIX I
DEFINITION OF TERMS

ACUTE TOXICITY

a. Acute Toxicity (TUa)

Expressed in Toxic Units Acute (TUa)

$$TUa = \frac{100}{\text{96-hr LC 50\%}}$$

b. Lethal Concentration 50% (LC 50)

LC 50 (percent waste giving 50% survival of test organisms) shall be determined by static or continuous flow bioassay techniques using standard marine test species as specified in Appendix III. If specific identifiable substances in wastewater can be demonstrated by the discharger as being rapidly rendered harmless upon discharge to the marine environment, but not as a result of dilution, the LC 50 may be determined after the test samples are adjusted to remove the influence of those substances.

When it is not possible to measure the 96-hour LC 50 due to greater than 50 percent survival of the test species in 100 percent waste, the toxicity concentration shall be calculated by the expression:

$$TUa = \frac{\log (100 - S)}{1.7}$$

where:

S = percentage survival in 100% waste. If S > 99, TUa shall be reported as zero.

ALL FORMS OF MARINE LIFE includes all life stages of all marine species.

AREA PRODUCTION FOREGONE (APF), also known as habitat production foregone, is an estimate of the area that is required to produce (replace) the same amount of larvae or propagules* that are removed via entrainment at a desalination facilities* intakes. APF is calculated by multiplying the proportional mortality* by the source water body,* which are both determined using an empirical transport model.*

AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) are those areas designated by the State Water Board as ocean areas requiring protection of species or biological communities to the extent that maintenance of natural water quality is assured. All Areas of Special Biological Significance are also classified as a subset of STATE WATER QUALITY PROTECTION AREAS.* ASBS are also referred to as State Water Quality Protection Areas* – Areas of Special Biological Significance (SWQPA-ASBS).

* See Appendix I for definition of terms.

BACTERIA WATER QUALITY OBJECTIVE(S) are the bacteria water quality objectives set forth in Chapter II.B.1.a.(1).

BASIN PLAN is a water quality control plan that consists of a designation or establishment for the waters within a specified area of all of the following: (1) Beneficial uses to be protected, (2) Water quality objectives, (3) A program of implementation needed for achieving water quality objectives.

BRINE is the byproduct of desalinated* water having a salinity* concentration greater than a desalination facility's* intake source water.

BRINE MIXING ZONE is the area where salinity* may exceed 2.0 parts per thousand above natural background salinity,* or the concentration of salinity* approved as part of an alternative receiving water limitation. The standard brine mixing zone shall not exceed 100 meters (328 feet) laterally from the points of discharge and throughout the water column. An alternative brine mixing zone, if approved as described in chapter III.M.3.d, shall not exceed 200 meters (656 feet) laterally from the points of discharge and throughout the water column. The brine mixing zone is an allocated impact zone where there may be toxic effects on marine life due to elevated salinity.

CALENDAR MONTH(S) is a period of time from a day of one month to the day before the corresponding day of the next month if the corresponding day exists, or if not to the last day of the next month (e.g. from January 1 to January 31, from June 15 to July 14, or from January 31 to February 28).

CHLORDANE shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.

CHRONIC TOXICITY: This parameter shall be used to measure the acceptability of waters for supporting a healthy marine biota until improved methods are developed to evaluate biological response.

a. Chronic Toxicity (TUc)

Expressed as Toxic Units Chronic (TUc)

$$TUc = \frac{100}{NOEL}$$

b. No Observed Effect Level (NOEL)

The NOEL is expressed as the maximum percent effluent or receiving water* that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test listed in Appendix III, Table III-1.

DDT shall mean the sum of 4,4'DDT, 2,4'DDT, 4,4'DDE, 2,4'DDE, 4,4'DDD, and 2,4'DDD.

* See Appendix I for definition of terms.

DEGRADE: Degradation shall be determined by comparison of the waste field and reference site(s) for characteristic species diversity, population density, contamination, growth anomalies, debility, or supplanting of normal species by undesirable plant and animal species. Degradation occurs if there are significant* differences in any of three major biotic groups, namely, demersal fish, benthic invertebrates, or attached algae. Other groups may be evaluated where benthic species are not affected, or are not the only ones affected.

DESALINATION FACILITY is an industrial facility that processes water to remove salts and other components from the source water to produce water that is less saline than the source water.

DICHLOROBENZENES shall mean the sum of 1,2- and 1,3-dichlorobenzene.

DOWNSTREAM OCEAN WATERS shall mean waters downstream with respect to ocean currents.

DREDGED MATERIAL: Any material* excavated or dredged from the navigable waters of the United States, including material* otherwise referred to as “spoil”.

EELGRASS BEDS are aggregations of the aquatic plant species of the genus *Zostera*.

EMPIRICAL TRANSPORT MODEL (ETM) is a methodology for determining the spatial area known as the source water body* that contains the source water population, which are the organisms that are at risk of entrainment as determined by factors that may include but are not limited to biological, hydrodynamic, and oceanographic data. ETM can also be used to estimate proportional mortality,* P_m.

ENCLOSED BAYS are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

ENDOSULFAN shall mean the sum of endosulfan-alpha and -beta and endosulfan sulfate.

ESTUARIES AND COASTAL LAGOONS are waters at the mouths of streams that serve as mixing zones for fresh and ocean* waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant* mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by section 12220 of the

* See Appendix I for definition of terms.

California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

ETM/APF APPROACH or ANALYSIS. For guidance on how to perform an ETM/APF analysis please see Appendix E of the Staff Report for Amendment to the Water Quality Control Plan For Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharges, And The Incorporation Of Other Non-substantive Changes.

FEASIBLE for the purposes of chapter III.M, shall mean capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

FLOW AUGMENTATION is a type of in-plant dilution and occurs when a desalination facility* withdraws additional source water for the specific purpose of diluting brine* prior to discharge.

FULL CAPTURE SYSTEM is a treatment control*, or series of treatment controls*, including but not limited to, a multi-benefit project* or a low-impact development control* that traps all particles that are 5 mm or greater, and has a design treatment capacity that is either: a) of not less than the peak flow rate, Q, resulting from a one-year, one-hour, storm in the subdrainage area, or b) appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain.

[Rational equation is used to compute the peak flow rate: $Q = C \bullet I \bullet A$, where Q = design flow rate (cubic feet per second, cfs); C = runoff coefficient (dimensionless); I = design rainfall intensity (inches per hour, as determined per the rainfall isohyetal map specific to each region, and A = subdrainage area (acres).]

Prior to installation, full capture systems* must be certified by the Executive Director, or designee, of the State Water Board. Uncertified full capture systems* will not satisfy the requirements of these Trash Provisions*. To request certification, a permittee shall submit a certification request letter that includes all relevant supporting documentation to the State Water Board's Executive Director. The Executive Director, or designee, shall issue a written determination approving or denying the certification of the proposed full capture system* or conditions of approval, including a schedule to review and reconsider the certification. Full capture systems* certified by the Los Angeles Regional Water Board prior to the effective date of these Trash Provisions* and full capture systems* listed in Appendix I of the Bay Area-wide Trash Capture Demonstration Project, Final Project Report (May 8, 2014) will satisfy the requirements of these Trash Provisions*, unless the Executive Director, or designee, of the State Water Board determines otherwise.

FULL CAPTURE SYSTEM EQUIVALENCY is the Trash* load that would be reduced if full capture systems* were installed, operated, and maintained for all storm drains

* See Appendix I for definition of terms.

that capture runoff from the relevant areas of land (priority land uses*, significant trash generating areas*, facilities or sites regulated by NPDES permits for discharges of storm water* associated with industrial activity, or specific land uses or areas that generate substantial amounts of Trash*, as applicable). The full capture system equivalency* is a Trash* load reduction target that the permittee quantifies by using an approach, and technically acceptable and defensible assumptions and methods for applying the approach, subject to the approval of permitting authority*. Examples of such approaches include, but are not limited to, the following:

(1) Trash Capture Rate Approach. Directly measure or otherwise determine the amount of Trash* captured by full capture systems* for representative samples of all similar types of land uses, facilities, or areas within the relevant areas of land over time to identify specific trash capture rates. Apply each specific Trash* capture rate across all similar types of land uses, facilities, or areas to determine full capture system equivalency*. Trash* capture rates may be determined either through a pilot study or literature review. Full capture systems* selected to evaluate Trash* capture rates may cover entire types of land uses, facilities, or areas, or a representative subset of types of land uses, facilities, or areas. With this approach, full capture system equivalency* is the sum of the products of each type of land use, facility, or area multiplied by Trash* capture rates for that type of land use, facility, or area.

(2) Reference Approach. Determine the amount of Trash* in a reference receiving water in a reference watershed where full capture systems* have been installed for all storm drains that capture runoff from all relevant areas of land. The reference watershed must be comprised of similar types and extent of sources of trash* and land uses (including priority land uses* and all other land uses), facilities, or areas as the permittee's watershed. With this approach, full capture system equivalency* would be demonstrated when the amount of Trash* in the receiving water is equivalent to the amount of Trash* in the reference receiving water.

GEOMETRIC MEAN (GM) is a type of mean or average that indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). The geometric mean is defined as the nth root of the product of n numbers. The formula is expressed as: GM = $\sqrt[n]{(x_1)(x_2)(x_3)\dots(x_n)}$, where *x* is the sample value and *n* is the number of samples taken.

GRAYWATER is drainage from galley, dishwasher, shower, laundry, bath, and lavatory wash basin sinks, and water fountains, but does not include drainage from toilets, urinals, hospitals, or cargo spaces.

HALOMETHANES shall mean the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride).

* See Appendix I for definition of terms.

HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.

INDICATOR BACTERIA includes total coliform bacteria, fecal coliform bacteria (or *E. coli*), and/or Enterococcus bacteria.

IN-KIND MITIGATION is when the habitat or species lost is the same as what is replaced through mitigation.

INSTITUTIONAL CONTROLS are non-structural best management practices (i.e., no structures are involved) that may include, but not be limited to, street sweeping, sidewalk Trash* bins, collection of the Trash*, anti-litter educational and outreach programs, producer take-back for packaging, and ordinances.

INITIAL DILUTION is the process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and nonbuoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant* mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.

KELP BEDS, are aggregations of marine algae of the order Laminariales, including species in the genera *Macrocystis, Nereocystis, and Pelagophycus*. Kelp beds include the total foliage canopy throughout the water column.

LARGE PASSENGER VESSELS are vessels of 300 gross registered tons or greater engaged in carrying passengers for hire. The following vessels are not large passenger vessels:

(1) Vessels without berths or overnight accommodations for passengers;
(2) Noncommercial vessels, warships, vessels operated by nonprofit entities as determined by the Internal Revenue Service, and vessels operated by the state, the United States, or a foreign government;
(3) Oceangoing vessels,* as defined below (e.g. those used to transport cargo).

LOW-IMPACT DEVELOPMENT CONTROLS are treatment controls* that employ natural and constructed features that reduce the rate of storm water* runoff, filter out

* See Appendix I for definition of terms.

pollutants, facilitate storm water* storage onsite, infiltrate storm water* into the ground to replenish groundwater supplies, or improve the quality of receiving groundwater and surface water. (See Water Code § 10564.)

LOEC is the lowest observed effect concentration or the lowest concentration of effluent that causes observable adverse effects in exposed test organisms.

MARICULTURE is the culture of algae, plants, and animals in marine waters independent of any pollution source.

MARINE MANAGED AREAS are named, discrete geographic marine or estuarine areas along the California coast designated by law or administrative action, and intended to protect, conserve, or otherwise manage a variety of resources and their uses. According to the California Public Resources Code (§§ 36600 et seq.) there are six classifications of marine managed areas, including State Marine Reserves, State Marine Parks and State Marine Conservation Areas, State Marine Cultural Preservation Areas, State Marine Recreational Management Areas, and State Water Quality Protection Areas.*

MARKET SQUID NURSURIES are comprised of numerous egg capsules, each containing approximately 200 developing embryos, attached in clusters or mops to sandy substrate with moderate water flow. Market squid (*Doryteuthis opalescens*) nurseries occur at a wide range of depths; however, mop densities are greatest in shallow, nearshore waters between ten and 100 meters (328 feet) deep.

MATERIAL: (a) In common usage: (1) the substance or substances of which a thing is made or composed (2) substantial; (b) For purposes of this Ocean Plan relating to waste disposal, dredging and the disposal of dredged material* and fill, MATERIAL means matter of any kind or description which is subject to regulation as waste, or any material dredged from the navigable waters of the United States. See also, DREDGED MATERIAL.* For the purposes of chapter III.M.2.d, materials relates to the common usage in (a).

METHOD DETECTION LIMIT (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as defined in 40 CFR PART 136 Appendix B.

MINIMUM LEVEL (ML) is the concentrations at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specified sample weights, volumes and processing steps have been followed.

MULTI-BENEFIT PROJECT is a treatment control* project designed to achieve any of the benefits set forth in section 10562, subdivision (d) of the Water Code. Examples

* See Appendix I for definition of terms.

include projects designed to: infiltrate, recharge or store storm water* for beneficial reuse; develop or enhance habitat and open space through storm water* and non-storm water management; and/or reduce storm water* and non-storm water runoff volume.

MULTIPORT DIFFUSERS are linear structures consisting of spaced ports or nozzles that are installed on submerged marine outfalls. For the purposes of chapter III.M, multiport diffusers discharge brine* waste into an ambient receiving water body and enable rapid mixing, dispersal, and dilution of brine* within a relatively small area.

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) has the same meaning set forth in 40 Code of Federal Regulations section 122.26(b)(8).

NATURAL BACKGROUND SALINITY is the salinity* at a location that results from naturally occurring processes and is without apparent human influence. For purposes of determining natural background salinity, the regional water board may approve the use of:

(1) the mean monthly natural background salinity. Mean monthly natural background salinity shall be determined by averaging 20 years of historical salinity* data in the proximity of the proposed discharge location and at the depth of the proposed discharge, when feasible.* For historical data not recorded in parts per thousand, the regional water boards may accept converted data at their discretion. When historical data are not available, natural background salinity shall be determined by measuring salinity* at depth of proposed discharge for three years, on a weekly basis prior to a desalination facility* discharging brine,* and the mean monthly natural salinity* shall be used to determine natural background salinity; or

(2) the actual salinity at a reference location, or reference locations, that is representative of natural background salinity at the discharge location. The reference locations shall be without apparent human influence, including wastewater outfalls and brine discharges.

Either method to establish natural background salinity may be used for the purpose of determining compliance with the receiving water limitation or an effluent limitation for salinity. If a reference location(s) is used for compliance monitoring, the permit should specify that historical data shall be used if reference location data becomes unavailable. An owner or operator shall submit to the regional water board all necessary information to establish natural background salinity.

NATURAL LIGHT: Reduction of natural light may be determined by the Regional Board by measurement of light transmissivity or total irradiance, or both, according to the monitoring needs of the Regional Board.

* See Appendix I for definition of terms.

NO DISCHARGE ZONE (NDZ) is an area in which both treated and untreated sewage discharges from vessels are prohibited. Within NDZ boundaries, vessel operators are required to retain their sewage discharges onboard for disposal at sea (beyond three miles from shore) or onshore at a pump-out facility.

NON-STORM WATER DISCHARGE is any runoff that is not the result of a precipitation event. This is often referred to as “dry weather flow.”

OCEAN WATERS are the territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays,* estuaries, and coastal lagoons.* If a discharge outside the territorial waters of the State could affect the quality of the waters of the State, the discharge may be regulated to assure no violation of the Ocean Plan will occur in ocean waters.

OCEANGOING VESSELS (i.e., oceangoing ships) means commercial vessels of 300 gross registered tons or more calling on California ports or places, excluding active military vessels.

OILY BILGE WATER includes bilge water that contains used lubrication oils, oil sludge and slops, fuel and oil sludge, used oil, used fuel and fuel filters, and oily waste.

OUT-OF-KIND MITIGATION is when the habitat or species lost is different than what is replaced through mitigation.

PAHs (polynuclear aromatic hydrocarbons) shall mean the sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

PCBs (polychlorinated biphenyls) shall mean the sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

PERMITTING AUTHORITY means the State Water Board or Regional Water Board, whichever issues the permit.

PREPRODUCTION PLASTIC has the same meaning set forth in section 13367(a) of the Water Code.

PRIORITY LAND USES are those developed sites, facilities, or land uses (i.e., not simply zoned land uses) within the MS4* permittee’s jurisdiction from which discharges of Trash* are regulated by this Ocean Plan as follows:

(1) **High-density residential:** all land uses with at least ten (10) developed dwelling units/acre.

* See Appendix I for definition of terms.

(2) **Industrial**: land uses where the primary activities on the developed parcels involve product manufacture, storage, or distribution (e.g., manufacturing businesses, warehouses, equipment storage lots, junkyards, wholesale businesses, distribution centers, or building material sales yards).

(3) **Commercial**: land uses where the primary activities on the developed parcels involve the sale or transfer of goods or services to consumers (e.g., business or professional buildings, shops, restaurants, theaters, vehicle repair shops, etc.)

(4) **Mixed urban**: land uses where high-density residential, industrial, and/or commercial land uses predominate collectively (i.e., are intermixed).

(5) **Public transportation stations**: facilities or sites where public transit agencies' vehicles load or unload passengers or goods (e.g., bus stations and stops).

Equivalent alternate land uses: An MS4* permittee with regulatory authority over priority land uses* may issue a request to the applicable permitting authority* that the MS4* permittee be allowed to substitute one or more land uses identified above with alternates land use within the MS4* permittee's jurisdiction that generates rates of Trash* that are equivalent to or greater than the priority land use(s)* being substituted. The land use area requested to substitute for a priority land use* need not be an acre-for-acre substitution but may involve one or more priority land uses*, or a fraction of a priority land use*, or both, provided the total trash* generated in the equivalent alternative land use is equivalent to or greater than the total Trash* generated from the priority land use(s)* for which substitution is requested. Comparative Trash* generation rates shall be established through the reporting of quantification measures such as street sweeping and catch basin cleanup records; mapping; visual trash presence surveys, such as the "Keep America Beautiful Visible Litter Survey"; or other information as required by the permitting authority*.

<u>PROPAGULES</u> are structures that are capable of propagating an organism to the next stage in its life cycle via dispersal. Dispersal is the movement of individuals from their birth site to their reproductive grounds.

<u>PROPORTIONAL MORTALITY</u>, P_m, is percentage of larval organisms or propagules* in the source water body* that is expected to be entrained at a desalination facility's* intake. It is assumed that all entrained larvae or propagules* die as a result of entrainment.

<u>RECEIVING WATER</u>, for permitted storm water discharges and nonpoint sources, should be measured at the point of discharge(s), in the surf zone immediately where runoff from an outfall meets the ocean water (a.k.a., at point zero).

* See Appendix I for definition of terms.

REFERENCE SYSTEM is a watershed or waterbody segment determined by the Water Board to be minimally disturbed by anthropogenic stresses but otherwise is representative of conditions of the assessed site, watershed, or water body segment.

SALINITY is a measure of the dissolved salts in a volume of water. For the purposes of this Plan, salinity shall be measured using a standard method approved by the regional water board (e.g. Standard Method 2520 B, EPA Method 120.1, EPA Method 160.1) and reported in parts per thousand (ppt). For historical salinity data not recorded in parts per thousand, the regional water boards may accept converted data at their discretion.

SEAWATER is salt water that is in or from the ocean. For the purposes chapter III.M, seawater includes tidally influenced waters in coastal estuaries and coastal lagoons* and underground salt water beneath the seafloor, beach, or other contiguous land with hydrologic connectivity to the ocean.

SENSITIVE HABITATS, for the purposes of this Plan, are kelp beds,* rocky substrate, surfgrass beds,* eelgrass beds,* oyster beds, spawning grounds for state or federally managed species, market squid nurseries,* or other habitats in need of special protection as determined by the Water Boards.

SHELLFISH are organisms identified by the California Department of Public Health as shellfish for public health purposes (i.e., mussels, clams and oysters).

SIGNIFICANT difference is defined as a statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level.

SIGNIFICANT TRASH GENERATING AREAS means all locations or facilities within the Department's jurisdiction where Trash* accumulates in substantial amounts, such as:

(1) Highway on- and off-ramps in high density residential, commercial, and industrial land uses (as such land uses are defined under priority land uses* herein).
(2) Rest areas and park-and-rides.
(3) State highways in commercial and industrial land uses (as such land uses are defined under priority land uses* herein).
(4) Mainline highway segments to be identified by the Department through pilot studies and/or surveys.

SINGLE SAMPLE MAXIMUM (SSM) is a maximum value not to be exceeded in any single sample.

SOURCE WATER BODY is the spatial area that contains the organisms that are at risk of entrainment at a desalination facility* as determined by factors that may include, but are not limited to, biological, hydrodynamic, and oceanographic data.

* See Appendix I for definition of terms.

<u>STATE WATER QUALITY PROTECTION AREAS (SWQPAs)</u> are nonterrestrial marine or estuarine areas designated to protect marine species or biological communities from an undesirable alteration in natural water quality. All Areas of Special Biological Significance (ASBS)* that were previously designated by the State Water Board in Resolutions 74-28, 74-32, and 75-61 are now also classified as a subset of State Water Quality Protection Areas and require special protections afforded by this Plan.

<u>STATE WATER QUALITY PROTECTION AREAS – GENERAL PROTECTION (SWQPA-GP)</u> designated by the State Water Board to protect marine species and biological communities from an undesirable alteration in natural water quality within State Marine Parks and State Marine Conservation Areas.

<u>STATISTICAL THRESHOLD VALUE (STV)</u> for the bacteria water quality objective* is a set value that approximates the 90th percentile of the water quality distribution of a bacterial population. The STV* for the bacteria water quality objective* is 110 cfu/100mL.

<u>STORM WATER</u> has the same meaning set forth in 40 Code of Federal Regulations section 122.26(b)(13) (Nov. 16, 1990).

<u>SUBSURFACE INTAKE</u>, for the purposes of chapter III.M, is an intake withdrawing seawater* from the area beneath the ocean floor or beneath the surface of the earth inland from the ocean.

<u>SURFGRASS BEDS</u> are aggregations of marine flowering plants of the genus *Phyllospadix*.

<u>TCDD EQUIVALENTS</u> shall mean the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown in the table below.

* See Appendix I for definition of terms.

Isomer Group	Toxicity Equivalence Factor
2,3,7,8-tetra CDD	1.0
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

TRASH means all improperly discarded solid material from any production, manufacturing, or processing operation including, but not limited to, products, product packaging, or containers constructed of plastic, steel, aluminum, glass, paper, or other synthetic or natural materials.

TRASH PROVISIONS are the water quality objective for Trash*, as well as the prohibition of discharge set forth in Chapter III.I and implementation requirements set forth in Chapter III.L herein.

TREATMENT CONTROLS are structural best management practices to either (a) remove pollutants and/or solids from storm water* runoff, wastewater, or effluent, or (b) capture, infiltrate or reuse storm water* runoff, wastewater, or effluent. Treatment controls include full capture systems* and low-impact development controls*.

WASTE: As used in this Plan, waste includes a discharger's total discharge, of whatever origin, i.e., gross, not net, discharge.

WATER RECLAMATION: The treatment of wastewater to render it suitable for reuse, the transportation of treated wastewater to the place of use, and the actual use of treated wastewater for a direct beneficial use or controlled use that would not otherwise occur.

WQS VARIANCE: A water quality standards variance**,** as defined by 40 Code of Federal Regulations section 131.3(o), is a time-limited designated use and criterion for a specific pollutant(s) or water quality parameter(s) that reflect the highest attainable condition during the term of the water quality standards variance.

* See Appendix I for definition of terms.

APPENDIX II
MINIMUM* LEVELS

The Minimum* Levels identified in this appendix represent the lowest concentration of a pollutant that can be quantitatively measured in a sample given the current state of performance in analytical chemistry methods in California. These Minimum* Levels were derived from data provided by state-certified analytical laboratories in 1997 and 1998 for pollutants regulated by the California Ocean Plan and shall be used until new values are adopted by the State Water Board. There are four major chemical groupings: volatile chemicals, semi-volatile chemicals, inorganics, pesticides & PCBs.* "No Data" is indicated by "--".

Table II-1
Minimum* Levels – Volatile Chemicals

Volatile Chemicals	CAS Number	Minimum* Level (µg/L): GC Method[a]	Minimum* Level (µg/L): GCMS Method[b]
Acrolein	107028	2.	5
Acrylonitrile	107131	2.	2
Benzene	71432	0.5	2
Bromoform	75252	0.5	2
Carbon Tetrachloride	56235	0.5	2
Chlorobenzene	108907	0.5	2
Chlorodibromomethane	124481	0.5	2
Chloroform	67663	0.5	2
1,2-Dichlorobenzene (volatile)	95501	0.5	2
1,3-Dichlorobenzene (volatile)	541731	0.5	2
1,4-Dichlorobenzene (volatile)	106467	0.5	2
Dichlorobromomethane	75274	0.5	2
1,1-Dichloroethane	75343	0.5	1
1,2-Dichloroethane	107062	0.5	2
1,1-Dichloroethylene	75354	0.5	2
Dichloromethane	75092	0.5	2
1,3-Dichloropropene (volatile)	542756	0.5	2
Ethyl benzene	100414	0.5	2
Methyl Bromide	74839	1.	2
Methyl Chloride	74873	0.5	2
1,1,2,2-Tetrachloroethane	79345	0.5	2
Tetrachloroethylene	127184	0.5	2
Toluene	108883	0.5	2
1,1,1-Trichloroethane	71556	0.5	2

* See Appendix I for definition of terms.

Volatile Chemicals	CAS Number	Minimum* Level (µg/L): GC Method[a]	Minimum* Level (µg/L): GCMS Method[b]
1,1,2-Trichloroethane	79005	0.5	2
Trichloroethylene	79016	0.5	2
Vinyl Chloride	75014	0.5	2

Table II-1 Notes

a) GC Method = Gas Chromatography
b) GCMS Method = Gas Chromatography / Mass Spectrometry
* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML (see chapter III, "Use of Minimum* Levels").

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* See Appendix I for definition of terms.

Table II-2
Minimum* Levels – Semi Volatile Chemicals

Semi-Volatile Chemicals	CAS Number	Minimum* Level (µg/L): GC Method [a, *]	Minimum* Level (µg/L): GCMS Method [b, *]	Minimum* Level (µg/L): HPLC Method [c,*]	Minimum* Level (µg/L): COLOR Method [d]
Acenapthylene	208968	--	10	0.2	--
Anthracene	120127	--	10	2	--
Benzidine	92875	--	5	--	--
Benzo(a)anthracene	56553	--	10	2	--
Benzo(a)pyrene	50328	--	10	2	--
Benzo(b)fluoranthene	205992	--	10	10	--
Benzo(g,h,i)perylene	191242	--	5	0.1	--
Benzo(k)floranthene	207089	--	10	2	--
Bis 2-(1-Chloroethoxy) methane	111911	--	5	--	--
Bis(2-Chloroethyl)ether	111444	10	1	--	--
Bis(2-Chloroisopropyl)ether	39638329	10	2	--	--
Bis(2-Ethylhexyl) phthalate	117817	10	5	--	--
2-Chlorophenol	95578	2	5	--	--
Chrysene	218019	--	10	5	--
Di-n-butyl phthalate	84742	--	10	--	--
Dibenzo(a,h)anthracene	53703	--	10	0.1	--
1,2-Dichlorobenzene (semivolatile)	95504	2	2	--	--
1,3-Dichlorobenzene (semivolatile)	541731	2	1	--	--
1,4-Dichlorobenzene (semivolatile)	106467	2	1	--	--
3,3-Dichlorobenzidine	91941	--	5	--	--
2,4-Dichlorophenol	120832	1	5	--	--
1,3-Dichloropropene	542756	--	5	--	
Diethyl phthalate	84662	10	2	--	--
Dimethyl phthalate	131113	10	2	--	--
2,4-Dimethylphenol	105679	1	2	--	--
2,4-Dinitrophenol	51285	5	5	--	--
2,4-Dinitrotoluene	121142	10	5	--	--
1,2-Diphenylhydrazine	122667	--	1	--	--
Fluoranthene	206440	10	1	0.05	--
Fluorene	86737	--	10	0.1	--
Hexachlorobenzene	118741	5	1	--	--

* See Appendix I for definition of terms.

Table II-2 (Continued)
Minimum* Levels – Semi Volatile Chemicals

Semi-Volatile Chemicals	CAS Number	Minimum* Level (µg/L): GC Method [a, *]	Minimum* Level (µg/L): GCMS Method [b, *]	Minimum* Level (µg/L): HPLC Method [c,*]	Minimum* Level (µg/L): COLOR Method [d]
Hexachlorobutadiene	87683	5	1	--	--
Hexachlorocyclopentadiene	77474	5	5	--	--
Hexachloroethane	67721	5	1	--	--
Indeno(1,2,3-cd)pyrene	193395	--	10	0.05	--
Isophorone	78591	10	1	--	--
2-methyl-4,6-dinitrophenol	534521	10	5	--	--
3-methyl-4-chlorophenol	59507	5	1	--	--
N-nitrosodi-n-propylamine	621647	10	5	--	--
N-nitrosodimethylamine	62759	10	5	--	--
N-nitrosodiphenylamine	86306	10	1	--	--
Nitrobenzene	98953	10	1	--	--
2-Nitrophenol	88755	--	10	--	--
4-Nitrophenol	100027	5	10	--	--
Pentachlorophenol	87865	1	5	--	--
Phenanthrene	85018	--	5	0.05	--
Phenol	108952	1	1	--	50
Pyrene	129000	--	10	0.05	--
2,4,6-Trichlorophenol	88062	10	10	--	--

Table II-2 Notes:

a) GC Method = Gas Chromatography
b) GCMS Method = Gas Chromatography / Mass Spectrometry
c) HPLC Method = High Pressure Liquid Chromatography
d) COLOR Method = Colorimetric
* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML* by 1000 (see chapter III, “Use of Minimum* Levels”).

* See Appendix I for definition of terms.

Table II-3
Minimum* Levels – Inorganics

Inorganic Substances	CAS Number	Minimum * Level (µg/L): COLOR Method[a]	Minimum * Level (µg/L): DCP Method[b]	Minimum * Level (µg/L): FAA Method[c]	Minimum * Level (µg/L): GFAA Method[d]	Minimum * Level (µg/L): HYDRIDE Method[e]	Minimum * Level (µg/L): ICP Method[f]	Minimum * Level (µg/L): ICPMS Method[g]	Minimum * Level (µg/L): SPGFAA Method[h]	Minimum * Level (µg/L): CVAA Method[i]
Antimony	7440360	--	1000.	10.	5.	0.5	50.	0.5	5.	--
Arsenic	7440382	20.	1000.	--	2.	1.	10.	2.	2.	--
Beryllium	7440417	--	1000.	20.	0.5	--	2.	0.5	1.	--
Cadmium	7440439	--	1000.	10.	0.5	--	10.	0.2	0.5	--
Chromium (total)	--	--	1000.	50.	2.	--	10.	0.5	1.	--
Chromium (VI)	18540299	10.	--	5.	--	--	--	--	--	--
Copper	7440508	--	1000.	20.	5.	--	10.	0.5	2.	--
Cyanide	57125	5.	--	--	--	--	--	--	--	--
Lead	7439921	--	10000.	20.	5.	--	5.	0.5	2.	--
Mercury	7439976	--	--	--	--	--	--	0.5	--	0.2
Nickel	7440020	--	1000.	50.	5.	--	20.	1.	5.	--
Selenium	7782492	--	1000.	--	5.	1.	10.	2.	5.	--
Silver	7440224	--	1000.	10.	1.	--	10.	0.2	2.	--
Thallium	7440280	--	1000.	10.	2.	--	10.	1.	5.	--
Zinc	7440666	--	1000.	20.	--	--	20.	1.	10.	--

Table II-3 Notes

a) COLOR Method = Colorimetric
b) DCP Method = Direct Current Plasma
c) FAA Method = Flame Atomic Absorption

* See Appendix I for definition of terms.

d) GFAA Method = Graphite Furnace Atomic Absorption
e) HYDRIDE Method = Gaseous Hydride Atomic Absorption
f) ICP Method = Inductively Coupled Plasma
g) ICPMS Method = Inductively Coupled Plasma / Mass Spectrometry
h) SPGFAA Method = Stabilized Platform Graphite Furnace Atomic Absorption (i.e., US EPA 200.9)
i) CVAA Method = Cold Vapor Atomic Absorption

* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML* (see chapter III, “Use of Minimum* Levels”).

* See Appendix I for definition of terms.

Table II-4
Minimum* Levels – Pesticides and PCBs*

Pesticides – PCBs	CAS Number	Minimum* Level (µg/L): GC Method[a],*
Aldrin	309002	0.005
Chlordane*	57749	0.1
4,4'-DDD	72548	0.05
4,4'-DDE	72559	0.05
4,4'-DDT	50293	0.01
Dieldrin	60571	0.01
a-Endosulfan	959988	0.02
b-Endosulfan	33213659	0.01
Endosulfan Sulfate	1031078	0.05
Endrin	72208	0.01
Heptachlor	76448	0.01
Heptachlor Epoxide	1024573	0.01
a-Hexachlorocyclohexane	319846	0.01
b-Hexachlorocyclohexane	319857	0.005
d-Hexachlorocyclohexane	319868	0.005
g-Hexachlorocyclohexane (Lindane)	58899	0.02
PCB 1016	--	0.5
PCB 1221	--	0.5
PCB 1232	--	0.5
PCB 1242	--	0.5
PCB 1248	--	0.5
PCB 1254	--	0.5
PCB 1260	--	0.5
Toxaphene	8001352	0.5

Table II-4 Notes

a) GC Method = Gas Chromatography

* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML* by 100 (see chapter III, “Use of Minimum* Levels”).

* See Appendix I for definition of terms.

APPENDIX III
STANDARD MONITORING PROCEDURES

1. INTRODUCTION

The purpose of this appendix is to provide guidance to the Regional Water Boards on implementing the Ocean Plan and to ensure the reporting of useful information. Monitoring should be question driven rather than just gathering data and should be focused on assuring compliance with narrative and numeric water quality standards, the status and attainment of beneficial uses, and identifying sources of pollution.

It is not feasible to prescribe requirements in the Ocean Plan that encompass all circumstances and conditions that could be encountered by all dischargers, nor is it desirable to limit the flexibility of the Regional Water Boards in the monitoring of ocean* waters. This appendix should therefore be considered the basic framework for the design of an ocean discharger monitoring program. The Regional Water Boards are responsible for issuing monitoring and reporting programs (MRPs) that will implement this monitoring guidance. Regional Water Boards can deviate from the procedures required in the appendix only with the approval of the State Water Resources Control Board.

This monitoring guidance utilizes a model monitoring framework. The model monitoring framework has three components that comprise a range of spatial and temporal scales: (1) core monitoring, (2) regional monitoring, and (3) special studies.

(1) Core monitoring consists of the basic site-specific monitoring necessary to measure compliance with individual effluent limits and/or impacts to receiving water* quality. Core monitoring is typically conducted in the immediate vicinity of the discharge by examining local scale spatial effects.

(2) Regional monitoring provides information necessary to make assessments over large areas and serves to evaluate cumulative effects of all anthropogenic inputs. Regional monitoring data also assists in the interpretation of core monitoring studies. It is recommended that the Regional Water Boards require participation by the discharger in an approved regional monitoring program, if available, for the receiving water.* In the event that a regional monitoring effort takes place during a permit cycle in which the MRP does not specifically address regional monitoring, a Regional Water Board may allow relief from aspects of core monitoring components in order to encourage participation.

(3) Special studies are directed monitoring efforts designed in response to specific management or research questions identified through either core or regional monitoring programs. Often they are used to help understand core or regional monitoring results, where a specific environmental process is not well understood, or to address unique issues of local importance. Regional Water Boards may require special studies as appropriate. Special studies are not addressed further in this guidance because they are beyond its scope.

* See Appendix I for definition of terms.

The Ocean Plan does not address all site-specific monitoring issues and allows the Regional Water Boards to select alternative protocols with the approval of the State Water Board. If no direction is given in this appendix for a specific provision of the Ocean Plan, it is within the discretion of the Regional Water Boards to establish the monitoring requirements for that provision.

2. QUALITY ASSURANCE

All receiving* and ambient water monitoring conducted in compliance with MRPs must be comparable with the Quality Assurance requirements of the Surface Water Ambient Monitoring Program (SWAMP).

SWAMP comparable means all sample collection and analyses shall meet or exceed the measurement quality objectives (MQOs) – including all sample types, frequencies, control limits and holding time requirements – as specified in the SWAMP Quality Assurance Project Plan (QAPrP)

The SWAMP QAPrP is located at:
http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa.

For those measurements that do not have SWAMP MQOs available, then MQOs shall be at the discretion of the Regional Water Board. Refer to the USEPA guidance document (EPA QA/G-4) for selecting data quality objectives, located at http://www.epa.gov/quality/qs-docs/g4-final.pdf.

Water Quality data must be reported according to the California Environmental Data Exchange Network (CEDEN) “Data Template” format for all constituents that are monitored in receiving and ambient water. CEDEN Data Template are available at: http://ceden.org.

3. TYPE OF WASTE DISCHARGE SOURCES

Discharges to ocean waters* are highly diverse and variable, exhibiting a wide range of constituents, effluent quality and quantity, location and frequency of discharge. Different types of discharges will require different approaches. This Appendix provides specific direction for three broad types of discharges: (1) Point Sources, (2) Storm Water Point Sources and (3) Non-point Sources.

3.1. Point Sources

Industrial, municipal, marine laboratory and other traditional point sources of pollution that discharge wastewater directly to surface waters and are required to obtain NPDES permits.

3.2. Storm Water Point Sources

Storm Water Point Sources, hereafter referred to as Storm Water Sources, are those NPDES permitted discharges regulated by Construction or Industrial Storm Water General Permits or municipal separate storm sewer system (MS4s) Permits. MS4

* See Appendix I for definition of terms.

Permits are further divided into Phase I and II Permits. A Phase I MS4 Permit is issued by a Regional Water Board for medium (serving between 100,000 and 250,000 people) and large (serving 250,000 or more people) municipalities. A Phase II MS4 General Permit is issued by the State Water Resources Control Board for the discharge of storm water for smaller municipalities, and includes nontraditional Small MS4s, which are governmental facilities such as military bases, public campuses, prison and hospital complexes.

3.3. Non-point Sources

A Non-point Source is any source of pollutants that is not a Point Source described in section 3.1 or a Storm Water Source as described in section 3.2. Land use categories contributing to non-point sources include but are not limited to:

a. Agriculture
b. Grazing
c. Forestry/timber harvest
d. Urban not covered under an NPDES permit
e. Marinas and mooring fields
f. Golf Courses not covered under an NPDES Permit

Only agricultural and golf course related non-point source discharge monitoring is addressed in this Appendix, but Regional Water Boards may issue MRPs for other non-point sources at their discretion. Agriculture includes irrigated lands. Irrigated lands are where water is applied for the purpose of producing crops, including, but not limited to, row and field crop, orchards, vineyard, rice production, nurseries, irrigated pastures, and managed wetlands.

4. INDICATOR BACTERIA*

4.1. Point Sources

Primary questions to be addressed:

1. Does the effluent comply with the water quality standards in the receiving water*?
2. Does the sewage effluent reach water contact zones or commercial shellfish* beds?

To answer these questions, core monitoring shall be conducted in receiving water* on the shoreline for the indicator bacteria* at a minimum weekly for any point sources discharging treated sewage effluent:

a. within one nautical mile of shore, or
b. within one nautical mile of a commercial shellfish* bed, or

* See Appendix I for definition of terms.

c. if the discharge is in excess of 10 million gallons per day (MGD).

Alternatively, these requirements may be met through participation in a regional monitoring program to assess the status of marine contact recreation water quality. If the permittee participates in a regional monitoring program, in conjunction with local health organization(s), core monitoring may be suspended for that period at the discretion of the Regional Water Board. Regional monitoring should be used to answer the above questions, and may be used to answer additional questions. These additional questions may include, but are not limited to, questions regarding the extent and magnitude of current or potential receiving water* indicator bacteria* problems, or the sources of indicator bacteria.*

4.2. Storm Water

Primary questions to be addressed:

1. Does the receiving water* comply with water quality standards?
2. Is the condition of the receiving water* protective of contact recreation and shellfish* harvesting beneficial uses?
3. Are the indicator bacteria* levels in receiving water* getting better or worse?
4. What is the relative contribution of indicator bacteria* to the receiving water* from storm water runoff?

To answer these questions, core monitoring for indicator bacteria* shall be required periodically for storm water discharges representative of the area of concern. At a minimum, for municipal storm water discharges, all receiving water* at outfalls greater than 36 inches in diameter or width must be monitored (ankle depth, point zero) at the following frequencies:

a. During wet weather with a minimum of three storms per year, and
b. When non-storm water discharges* occur (flowing during dry weather), and if located at an AB 411 beach, at least weekly. (An AB 411 Beach is defined as a beach visited by more than 50,000 people annually and located on an area adjacent to a storm drain that flows in the summer. (Health & Saf. Code § 115880.)).

Regional Water Boards may waive monitoring once structural best management practices have been installed, evaluated and determined to have successfully controlled indicator bacteria.*

Alternatively, these requirements may be met through participation in a regional monitoring program to assess the status of marine contact recreation water quality. If the permittee participates in a regional monitoring program, in conjunction with local health organization(s), core monitoring may be suspended for that period at the discretion of the Regional Water Board. Regional monitoring should be used to answer

* See Appendix I for definition of terms.

the above questions, and may be used to answer additional questions. These additional questions may include, but are not limited to, questions regarding the extent and magnitude of current or potential receiving water* indicator bacteria* problems, or the sources of indicator bacteria.*

4.3. Non-point Sources

Primary questions to be addressed:

1. Does the receiving water* comply with water quality standards?
2. Do agricultural and golf course non-point source discharges reach water contact or shellfish* harvesting zones?
3. Are the indicator bacteria* levels in receiving water* getting better or worse?
4. What is the relative contribution of indicator bacteria* to the receiving water* from agricultural and golf course non-point sources?

To answer these questions, core monitoring of representative agricultural irrigation tail water and storm water runoff, at a minimum, will be conducted in receiving water* (ankle depth, point zero) for indicator bacteria*:

a. During wet weather, at a minimum of two storm events per year, and
b. When non-storm water discharges* occur (flowing during dry weather), and if located at an AB 411 beach or within one nautical mile of shellfish* bed, at least weekly.

Alternatively, these requirements may be met through participation in a regional monitoring program to assess the status of marine contact recreation water quality. If the discharger participates in a regional monitoring program, in conjunction with local health organization(s), core monitoring may be suspended for that period at the discretion of the Regional Water Board. Regional monitoring should be used to answer the above questions, and may be used to answer additional questions. These additional questions may include, but are not limited to, questions regarding the extent and magnitude of current or potential receiving water* indicator bacteria* problems, or the sources of indicator bacteria.*

5. CHEMICAL CONSTITUENTS

5.1. Point Sources

Primary questions addressed:

1. Does the effluent meet permit effluent limits thereby ensuring that water quality standards are achieved in the receiving water*?
2. What is the mass of the constituents that are discharged annually?
3. Is the effluent concentration or mass changing over time?

* See Appendix I for definition of terms.

Consistent with Appendix VI, the core monitoring for the substances in Table 3 and Table 4 shall be required periodically. For discharges less than 10 MGD, the monitoring frequency shall be at least one complete scan of the Table 3 substances annually. Discharges greater than 10 MGD shall be required to monitor at least semiannually.

5.2. Storm Water

Primary questions addressed:

1. Does the receiving water* meet the water quality standards?
2. Are the conditions in receiving water* getting better or worse?
3. What is the relative runoff contribution to pollution in the receiving water*?

For Phase I and Phase II MS4 dischargers, core receiving water* monitoring will be required at a minimum for 10 percent of all outfalls greater than 36 inches in diameter or width once per year. If a discharger has less than five outfalls exceeding 36 inches in diameter or width, they shall conduct monitoring at a minimum of only once per outfall during a five year period. Monitoring shall be for total suspended solids, oil & grease, total organic carbon, pH, temperature, biochemical oxygen demand, turbidity, Table 3 metals, PAHs,* and pesticides determined by the Regional Water Boards. Regional Water Boards may waive monitoring once structural best management practices have been installed, evaluated and determined to have successfully controlled pollutants.

For industrial storm water discharges, runoff monitoring must be conducted at all outfalls at least two storm events per year. In addition, at least one representative receiving water* sample must be collected per industrial storm water permittee during two storm events per year. Monitoring shall be conducted for total suspended solids, oil & grease, total organic carbon, pH, temperature, biochemical oxygen demand, turbidity, and Table 3 metals and PAHs.*

The requirements for individual core monitoring for Table 3 metals, PAHs* and pesticides may be waived at the discretion of the Regional Water Board, if the permittee participates in a regional program for monitoring runoff and/or receiving water* to answer the above questions as well as additional questions. Additional questions may include, but are not limited to, questions regarding the extent and magnitude of current or potential receiving water* problems from storm water runoff, or sources of any runoff pollutants.

5.3. Non-point Sources

The primary questions are:

1. Does the agricultural or golf course runoff meet water quality standards in the receiving water*?

* See Appendix I for definition of terms.

2. Are nutrients present that would contribute to objectionable aquatic algal blooms or degrade* indigenous biota?
3. Are the conditions in receiving water* getting better or worse?
4. What is the relative agricultural runoff or golf course contribution to pollution in the receiving water*?

To answer these questions, a statistically representative sample (determined by the Regional Water Board) of receiving water* at the sites of agricultural irrigation tail water and storm water runoff, and golf course runoff in each watershed will be monitored for Ocean Plan Table 3 metals, ammonia as N, nitrate as N, phosphate as P, and pesticides determined by the Regional Board:

a. During wet weather, at a minimum of two storm events per year, and
b. During dry weather, when flowing, at a frequency determined by the Regional Boards.

This requirement may be satisfied by core monitoring individually, or through participation in a regional program for monitoring runoff and receiving water* at the discretion of the Regional Water Board to answer the above questions as well as additional questions. Additional questions may include, but are not limited to, questions regarding the sources of agricultural pollutants.

6. SEDIMENT MONITORING
All Sources:

1. Is the dissolved sulfide concentration of waters in sediments significantly* increased above that present under natural conditions?
2. Is the concentration of substances set forth in Table 3, for protection of marine aquatic life, in marine sediments at levels which would degrade* the benthic community?
3. Is the concentration of organic pollutants in marine sediments at levels that would degrade* the benthic community?

6.1. Point Sources

For discharges greater than 10 MGD, acid volatile sulfides, OP Pesticides, Table 3 metals, ammonia N, PAHs,* and chlorinated hydrocarbons will be measured in sediments annually in a core monitoring program approved by the Regional Water Board. Sediment sample locations will be determined by the Regional Water Board. If sufficient data exists from previous water column monitoring for these parameters, the Regional Water Board at its discretion may reduce the frequency of monitoring, or may allow this requirement to be satisfied through participation in a regional monitoring program.

* See Appendix I for definition of terms.

6.2. Storm Water

For Phase I MS4 permittees, discharges greater than 72 inches in diameter or width discharging to low energy coastal environments with the likelihood of sediment deposition, acid volatile sulfides, OP Pesticides, Ocean Plan Table 3 metals, ammonia N, PAHs,* and chlorinated hydrocarbons will be measured in sediments once per permit cycle.

Regional Water Boards may waive monitoring once structural best management practices have been installed, evaluated and determined to have successfully controlled pollutants.

This requirement may be satisfied by core monitoring individually or through participation in a regional monitoring program at the discretion of the Regional Water Board. Sediment sample locations will be determined by the Regional Water Board.

7. AQUATIC LIFE TOXICITY

Toxicity tests are another method used to assess risk to aquatic life. These tests assess the overall toxicity of the effluent, including the toxicity of unmeasured constituents and/or synergistic effects of multiple constituents.

7.1. Point Sources

1. Does the effluent meet permit effluent limits for toxicity thereby ensuring that water quality standards are achieved in the receiving water*?
2. If not:
    a. Are unmeasured pollutants causing risk to aquatic life?
    b. Are pollutants in combinations causing risk to aquatic life?

Core monitoring for Table 3 effluent toxicity shall be required periodically. For discharges less than 0.1 MGD the monitoring frequency for acute and/or chronic toxicity* shall be twice per permit cycle. For discharges between 0.1 and 10 MGD, the monitoring frequency for acute and/or chronic toxicity* of the effluent should be at least annually. For discharges greater than 10 MGD, the monitoring frequency for acute and/or chronic toxicity* of the effluent should be at least semiannually.

For discharges greater than 10 MGD in a low energy coastal environment with the likelihood of sediment deposition, Core monitoring for acute sediment toxicity is required and will utilize alternative amphipod species (*Eohaustorius estuarius, Leptocheirus plumulosus, Rhepoxynius abronius*).

If an exceedance is detected, six additional toxicity tests are required within a 12-week period. If an additional exceedance is detected within the 12-week period, a toxicity reduction evaluation (TRE) is required, consistent with chapter III.C.10 that requires a

* See Appendix I for definition of terms.

TRE if a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table 3.

7.2. Storm Water

1. Does the runoff meet objectives for toxicity in the receiving water*?
2. Are the conditions in receiving water* getting better or worse with regard to toxicity
3. What is the relative runoff contribution to the receiving water* toxicity?
4. What are the causes of the toxicity and the sources of the constituents responsible?

For Phase I MS4, Phase II MS4, and industrial storm water discharges, core toxicity monitoring will be required at a minimum for 10 percent of all outfalls greater than 36 inches in diameter or width at a minimum of once per year. Receiving water* monitoring shall be for Table 3 critical life stage chronic toxicity* for a minimum of one invertebrate species.

For storm water discharges greater than 72 inches in diameter or width in a low energy coastal environment with the likelihood of sediment deposition, core sediment monitoring for acute sediment toxicity is required and will utilize alternative amphipod species (*Eohaustorius estuarius, Leptocheirus plumulosus, Rhepoxynius abronius*).

Regional Water Boards may waive monitoring once structural best management practices have been installed, evaluated and determined to have successfully controlled toxicity.

If an exceedence is detected, an additional toxicity test is required during the subsequent storm event. If an additional exceedance is detected at that time, a TRE is required, consistent with chapter III.C.10 that requires a TRE if a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table 3. A sufficient volume must be collected to conduct a TIE, if necessary, as a part of a TRE.

The requirement for core toxicity monitoring may be waived at the discretion of the Regional Water Board, if the permittee participates in a regional monitoring program to answer the above questions, as well as any other additional questions that may be developed by the regional monitoring program.

7.3. Non-point Sources

1. Does the agricultural and golf course runoff meet water quality standards for toxicity in the receiving water*?
2. Are the conditions in receiving water* getting better or worse with regard to toxicity?

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* See Appendix I for definition of terms.

3. What is the relative agricultural and golf course runoff contribution to receiving water* toxicity?
4. What are the causes of the toxicity, and the sources of the constituents responsible?

To answer these questions, a statistically representative sample (determined by the Regional Water Board) of receiving water* at the sites of agricultural irrigation tail water and storm water runoff, and golf course runoff, in each watershed will be monitored:

a. During wet weather, at a minimum of two storm events per year, and
b. During dry weather, when flowing, at a frequency determined by the Regional Boards.

Core receiving water* monitoring shall include Table 3 critical life stage chronic toxicity* for a minimum of one invertebrate species.

For runoff in a low energy coastal environment with the likelihood of sediment deposition, core sediment monitoring shall include acute sediment toxicity utilizing alternative amphipod species (*Eohaustorius estuarius, Leptocheirus plumulosus, Rhepoxynius abronius*) at a minimum once per year.

If an exceedence is detected, an additional toxicity test is required during the subsequent storm event. If an additional exceedance is detected, a TRE is required, consistent with chapter III.C.10 that requires a TRE if a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table 3. A sufficient volume must be collected to conduct a TIE, if necessary, as a part of a TRE.

The requirement for core monitoring may be waived at the discretion of the Regional Water Board, if the permittee participates in a regional monitoring program to answer the above questions, as well as any other additional questions that may be developed by the regional monitoring program.

8. BENTHIC COMMUNITY HEALTH

8.1. Point Sources

1. Are benthic communities degraded* as a result of the discharge?

To answer this question, benthic community monitoring shall be conducted

a. for all discharges greater than 10 MGD, or
b. those discharges greater than 0.1 MGD and one nautical mile or less from shore, or
c. discharges greater than 0.1 MGD and one nautical mile or less from a State Water Quality Protection Area* or a State Marine Reserve.

* See Appendix I for definition of terms.

The minimum frequency shall be once per permit cycle, except for discharges greater than 100 MGD the minimum frequency shall be at least twice per permit cycle.

This requirement may be satisfied by core monitoring individually or through participation in a regional monitoring program at the discretion of the Regional Board.

9. BIOACCUMULATION

9.1. Point Sources

1. Does the concentration of pollutants in fish, shellfish,* or other marine resources used for human consumption bioaccumulate to levels that are harmful to human health?
2. Does the concentration of pollutants in marine life bioaccumulate to levels that degrade* marine communities?

To answer these questions, bioaccumulation monitoring shall be conducted, at a minimum, once per permit cycle for:

a. discharges greater than 10 MGD, or
b. those discharges greater than 0.1 MGD and one nautical mile or less from shore, or
c. discharges greater than 0.1 MGD and one nautical mile or less from a State Water Quality Protection Area* or a State Marine Reserve, Park or Conservation Area.

Constituents to be monitored must include pesticides (at the discretion of the Regional Board), Table 3 metals, and PAHs.* Bioaccumulation may be monitored by a mussel watch program or a fish tissue program. Resident mussels are preferred over transplanted mussels. Sand crabs and/or fish may be added or substituted for mussels at the discretion of the Regional Water Board.

This requirement may be satisfied individually as core monitoring or through participation in a regional monitoring program at the discretion of the Regional Water Board.

9.2. Storm Water

1. Does the concentration of pollutants in fish, shellfish,* or other marine resources used for human consumption bioaccumulate to levels that are harmful to human health?
2. Does the concentration of pollutants in marine life bioaccumulate to levels that degrade* marine communities?

For Phase I MS4 dischargers, bioaccumulation monitoring shall be conducted, at a minimum, once per permit cycle. Constituents to be monitored must include OP

* See Appendix I for definition of terms.

Pesticides, Ocean Plan Table 3 metals, Table 3 PAHs,* Table 3 chlorinated hydrocarbons, and pyrethroids. Bioaccumulation may be monitored by a mussel watch program or a fish tissue program. Sand crabs, fish, and/or Solid Phase Microextraction may be added or substituted for mussels at the discretion of the Regional Water Board.

This requirement may be satisfied individually as core monitoring or through participation in a regional monitoring program at the discretion of the Regional Water Board.

10. RECEIVING WATER* CHARACTERISTICS
All Sources:

1. Is natural light* significantly* reduced at any point outside the zone of initial dilution* as the result of the discharge of waste*?
2. Does the discharge of waste* cause a discoloration of the ocean surface?
3. Does the discharge of oxygen demanding waste* cause the dissolved oxygen concentration to be depressed at any time more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding* waste* materials*?
4. Does the discharge of waste* cause the pH to change at any time more than 0.2 units from that which occurs naturally?
5. Does the discharge of waste* cause the salinity* to become elevated in the receiving water*?
6. Do nutrients cause objectionable aquatic growth or degrade* indigenous biota?

10.1. Point Sources

For discharges greater than 10 MGD, turbidity (alternatively light transmissivity or surface water transparency), color [Chlorophyll-A and/or color dissolved organic matter (CDOM)], dissolved oxygen and pH shall be measured in the receiving water* seasonally, at a minimum, in a core monitoring program approved by the Regional Water Board. If sufficient data exists from previous water column monitoring for these parameters, the Regional Water Board, at its discretion, may reduce the frequency of water column monitoring, or may allow this requirement to be satisfied through participation in a regional monitoring program. Use of regional ocean observing programs, such as the Southern California Coastal Ocean Observing System (SCCOOS) and the Central and Northern California Ocean Observing System (CeNCCOOS) is encouraged.

Salinity* must also be monitored by all point sources discharging brine* as part of their core monitoring program. Seawater desalination facilities* discharging brine* into ocean waters* and wastewater facilities that receive brine from seawater desalination facilities and discharge into ocean waters shall monitor salinity as described in chapter III.M.4.

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* See Appendix I for definition of terms.

10.2. Storm Water

At a minimum, 10 percent of Phase I MS4 discharges greater than 36 inches, receiving water* turbidity, color, dissolved oxygen, pH, nitrate, phosphate, and ammonia shall be measured annually in a core monitoring program approved by the Regional Water Board.

Regional Water Boards may waive monitoring once structural best management practices have been installed, evaluated and determined to have successfully controlled pollutants. The Regional Water Board, at its discretion, may also allow this requirement to be satisfied through participation in a regional monitoring program.

10.3. Non-point Sources

Representative agricultural and golf course discharges shall be measured, at a minimum twice annually (during two storm season and irrigation season) for receiving water* turbidity, color, dissolved oxygen, pH, nitrate, phosphate, ammonia in a core monitoring program approved by the Regional Water Board. The Regional Water Board, at its discretion, may allow this requirement to be satisfied through participation in a regional monitoring program.

11. ANALYTICAL REQUIREMENTS

Procedures, calibration techniques, and instrument/reagent specifications shall conform to the requirements of 40 CFR PART 136. Compliance monitoring shall be determined using an US EPA approved protocol as provided in 40 CFR PART 136. All methods shall be specified in the monitoring requirement section of waste* discharge requirements.

Where methods are not available in 40 CFR PART 136, the Regional Water Boards shall specify suitable analytical methods in waste* discharge requirements. Acceptance of data should be predicated on demonstrated laboratory performance.

Laboratories analyzing monitoring data shall be certified by the California Department of Public Health, in accordance with the provisions of Water Code section 13176, and must include quality assurance quality control data with their reports.

Sample dilutions for total and fecal coliform bacterial analyses shall range from 2 to 16,000. Sample dilutions for enterococcus bacterial analyses shall range from 1 to 10,000 per 100 mL. Each test method number or name (e.g., EPA 600/4-85/076, Test Methods for *Escherichia coli* and *Enterococci* in Water by Membrane Filter Procedure) used for each analysis shall be specified and reported with the results.

Test methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 CFR PART 136, unless alternate methods have been approved in advance by U.S. EPA pursuant to 40 CFR PART 136.

* See Appendix I for definition of terms.

Test methods used for enterococcus shall be those presented in U.S. EPA publication EPA 600/4-85/076, Test Methods for *Escherichia coli* and *Enterococci* in Water by Membrane Filter Procedure or any improved method determined by the Regional Board to be appropriate. The Regional Water Board may allow analysis for *Escherichia coli* (*E. coli)* by approved test methods to be substituted for fecal coliforms if sufficient information exists to support comparability with approved methods and substitute the existing methods.

The State or Regional Water Board may, subject to U.S. EPA approval, specify test methods which are more sensitive than those specified in 40 CFR PART 136. Because storm water and non-point sources are not assigned a dilution factor, sufficient sampling and analysis shall be required to determine compliance with Table 3 Water Quality Objectives. Total chlorine residual is likely to be a method detection limit effluent limitation in many cases. The limit of detection of total chlorine residual in standard test methods is less than or equal to 20 µg/L.

Toxicity monitoring requirements in permits prepared by the Regional Water Boards shall use marine test species instead of freshwater species when measuring compliance. The Regional Water Board shall require the use of critical life stage toxicity tests specified in this Appendix to measure TUc. For Point Sources, a minimum of three test species with approved test protocols shall be used to measure compliance with the toxicity objective. If possible, the test species shall include a fish, an invertebrate, and an aquatic plant. After a screening period, monitoring can be reduced to the most sensitive species.

Dilution and control water should be obtained from an unaffected area of the receiving waters.* The sensitivity of the test organisms to a reference toxicant shall be determined concurrently with each bioassay test and reported with the test results.

Use of critical life stage bioassay testing shall be included in waste* discharge requirements as a monitoring requirement for all Point Source discharges greater than 100 MGD

Procedures and methods used to determine compliance with benthic monitoring should use the following federal guidelines when applicable: Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (1990) -- EPA/600/4-90/030 (PB91-171363). This manual describes guidelines and standardized procedures for the use of macroinvertebrates in evaluating the biological integrity of surface waters.

Procedures used to determine compliance with bioaccumulation monitoring should use the U.S. EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (November 2000, EPA 823-B-00-007), NOAA Technical Memorandum NOS ORCA 130, Sampling and Analytical Methods of the National Status and Trends Program Mussel Watch Project (1998 update), and/or State Mussel Watch Program, 1987-1993 Data Report, State Water Resources Control Board 94-1WQ.

* See Appendix I for definition of terms.

Table III-1
Approved Tests – Chronic Toxicity* (TUc)

Species	Effect	Tier	Reference
giant kelp, Macrocystis pyrifera	percent germination; germ tube length	1	1,3
red abalone, Haliotis rufescens	Abnormal shell development	1	1,3
oyster, Crassostrea gigas; mussels, Mytilus spp.	Abnormal shell development; percent survival	1	1,3
urchin, Strongylocentrotus purpuratus; sand dollar, Dendraster excentricus	Percent normal development	1	1,3
urchin, Strongylocentrotus purpuratus; sand dollar, Dendraster excentricus	Percent fertilization	1	1,3
shrimp, Holmesimysis costata	Percent survival; growth	1	1,3
shrimp, Mysidopsis bahia	Percent survival; growth; fecundity	2	2,4
topsmelt, Atherinops affinis	Larval growth rate; percent survival	1	1,3
Silversides, Menidia beryllina	Larval growth rate; percent survival	2	2,4

Table III-1 Notes

The first tier test methods are the preferred toxicity tests for compliance monitoring. A Regional Water Board can approve the use of a second tier test method for waste* discharges if first tier organisms are not available.

Protocol References

1. Chapman, G.A., D.L. Denton, and J.M. Lazorchak. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. U.S. EPA Report No. EPA/600/R-95/136.
2. Klemm, D.J., G.E. Morrison, T.J. Norberg-King, W.J. Peltier, and M.A. Heber. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving water to marine and estuarine organisms. U.S. EPA Report No. EPA-600-4-91-003.
3. SWRCB 1996. Procedures Manual for Conducting Toxicity Tests Developed by the Marine Bioassay Project. 96-1WQ.
4. Weber, C.I., W.B. Horning, I.I., D.J. Klemm, T.W. Nieheisel, P.A. Lewis, E.L. Robinson, J. Menkedick and F. Kessler (eds). 1988. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028. National Information Service, Springfield, VA.

* See Appendix I for definition of terms.

APPENDIX IV
PROCEDURES FOR THE NOMINATION AND DESIGNATION OF STATE WATER QUALITY PROTECTION AREAS.*

1. Any person may nominate areas of ocean* waters for designation as SWQPA-ASBS or SWQPA-GP by the State Water Board. Nominations shall be made to the appropriate Regional Water Board and shall include:

   (a) Information such as maps, reports, data, statements, and photographs to show that:

      (1) Candidate areas are located in ocean* waters as defined in the "Ocean Plan".
      (2) Candidate areas are intrinsically valuable or have recognized value to man for scientific study, commercial use, recreational use, or esthetic reasons.
      (3) Candidate areas need protection beyond that offered by waste* discharge restrictions or other administrative and statutory mechanisms.

   (b) Data and information to indicate whether the proposed designation may have a significant* effect on the environment.

      (1) If the data or information indicate that the proposed designation will have a significant* effect on the environment, the nominee must submit sufficient information and data to identify feasible changes in the designation that will mitigate or avoid the significant* environmental effects.

2. The State Water Board or a Regional Water Board may also nominate areas for designation as SWQPA-ASBS or SWQPA-GP on their own motion.

3. A Regional Water Board may decide to (a) consider individual SWQPA-ASBS or SWQPA-GP nominations upon receipt, (b) consider several nominations in a consolidated proceeding, or (c) consider nominations in the triennial review of its water quality control plan (basin plan). A nomination that meets the requirements of 1. above may be considered at any time but not later than the next scheduled triennial review of the appropriate basin plan or Ocean Plan.

4. After determining that a nomination meets the requirements of paragraph 1. above, the Executive Officer of the affected Regional Water Board shall prepare a Draft Nomination Report containing the following:

   (a) The area or areas nominated for designation as SWQPA-ASBS or SWQPA-GP.

   (b) A description of each area including a map delineating the boundaries of each proposed area.

   (c) A recommendation for action on the nomination(s) and the rationale for the recommendation. If the Draft Nomination Report recommends approval of the proposed designation, the Draft Nomination Report shall comply with the CEQA

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* See Appendix I for definition of terms.

documentation requirements for a water quality control plan amendment in section 3777, title 23, California Code of Regulations.

5. The Executive Officer shall, at a minimum, seek informal comment on the Draft Nomination Report from the State Water Board, Department of Fish and Game, other interested state and federal agencies, conservation groups, affected waste dischargers, and other interested parties. Upon incorporation of responses from the consulted agencies, the Draft Nomination Report shall become the Final Nomination Report.

6. (a) If the Final Nomination Report recommends approval of the proposed designation, the Executive Officer shall ensure that processing of the nomination complies with the CEQA consultation requirements in section 3778, Title 23, California Code of Regulations and proceed to step 7 below.

   (b) If the Final Nomination Report recommends against approval of the proposed designation, the Executive Officer shall notify interested parties of the decision. No further action need be taken. The nominating party may seek reconsideration of the decision by the Regional Water Board itself.

7. The Regional Water Board shall conduct a public hearing to receive testimony on the proposed designation. Notice of the hearing shall be published three times in a newspaper of general circulation in the vicinity of the proposed area or areas and shall be distributed to all known interested parties 45 days in advance of the hearing. The notice shall describe the location, boundaries, and extent of the area or areas under consideration, as well as proposed restrictions on waste* discharges within the area.

8. The Regional Water Board shall respond to comments as required in section 3779, Title 23, California Code of Regulations, and 40 C.F.R. Part 25 (July 1, 1999).

9. The Regional Water Board shall consider the nomination after completing the required public review processes required by CEQA.

   (a) If the Regional Water Board supports the recommendation for designation, the board shall forward to the State Water Board its recommendation for approving designation of the proposed area or areas and the supporting rationale. The Regional Water Board submittal shall include a copy of the staff report, hearing transcript, comments, and responses to comments.

   (b) If the Regional Water Board does not support the recommendation for designation, the Executive Officer shall notify interested parties of the decision, and no further action need be taken.

10. After considering the Regional Water Board recommendation and hearing record, the State Water Board may approve or deny the recommendation, refer the matter to the Regional Water Board for appropriate action, or conduct further hearing itself. If

* See Appendix I for definition of terms.

the State Water Board acts to approve a recommended designation, the State Water Board shall amend Appendix V, Table V-1, of this Plan. The amendment will go into effect after approval by the Office of Administrative Law and US EPA. In addition, after the effective date of a designation, the affected Regional Water Board shall revise its water quality control plan in the next triennial review to include the designation.

11. The State Water Board Executive Director shall advise other agencies to whom the list of designated areas is to be provided that the basis for an SWQPA-ASBS or SWQPA-GP designation is limited to protection of marine life from waste* discharges.

* See Appendix I for definition of terms.

APPENDIX V
STATE WATER QUALITY PROTECTION AREAS*
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE*

Table V-1
State Water Quality Protection Areas*
Areas of Special Biological Significance*
(Designated or Approved by the State Water Resources Control Board)

No.	ASBS Name	Date Designated	State Water Board Resolution No.	Region No.
1.	Jughandle Cove	March 21, 1974,	74-28	1
2.	Del Mar Landing	March 21, 1974,	74-28	1
3.	Gerstle Cove	March 21, 1974,	74-28	1
4.	Bodega	March 21, 1974,	74-28	1
5.	Saunders Reef	March 21, 1974,	74-28	1
6.	Trinidad Head	March 21, 1974,	74-28	1
7.	King Range	March 21, 1974,	74-28	1
8.	Redwoods National Park	March 21, 1974,	74-28	1
9.	James V. Fitzgerald	March 21, 1974,	74-28	2
10.	Farallon Islands	March 21, 1974,	74-28	2
11.	Duxbury Reef	March 21, 1974,	74-28	2
12.	Point Reyes Headlands	March 21, 1974,	74-28	2
13.	Double Point	March 21, 1974,	74-28	2
14.	Bird Rock	March 21, 1974,	74-28	2
15.	Año Nuevo	March 21, 1974,	74-28	3
16.	Point Lobos	March 21, 1974,	74-28	3
17.	San Miguel, Santa Rosa, and Santa Cruz Islands	March 21, 1974,	74-28	3
18.	Julia Pfeiffer Burns	March 21, 1974,	74-28	3
19.	Pacific Grove	March 21, 1974,	74-28	3
20.	Salmon Creek Coast	March 21, 1974,	74-28	3
21.	San Nicolas Island and Begg Rock	March 21, 1974,	74-28	4
22.	Santa Barbara and Anacapa Islands	March 21, 1974,	74-28	4
23.	San Clemente Island	March 21, 1974,	74-28	4
24.	Laguna Point to Latigo Point	March 21, 1974,	74-28	4

* See Appendix I for definition of terms.

No.	ASBS Name	Date Designated	State Water Board Resolution No.	Region No.
25.	Northwest Santa Catalina Island	March 21, 1974,	74-28	4
26.	Western Santa Catalina Island	March 21, 1974,	74-28	4
27.	Farnsworth Bank	March 21, 1974,	74-28	4
28.	Southeast Santa Catalina	March 21, 1974,	74-28	4
29.	La Jolla	March 21, 1974,	74-28	9
30.	Heisler Park	March 21, 1974,	74-28	9
31.	San Diego-Scripps	March 21, 1974,	74-28	9
32.	Robert E. Badham	April 18, 1974	74-32	8
33.	Irvine Coast	April 18, 1974	74-32	8,9
34.	Carmel Bay	June 19, 1975	75-61	3

* See Appendix I for definition of terms.

APPENDIX VI
REASONABLE POTENTIAL ANALYSIS PROCEDURE FOR DETERMINING WHICH TABLE 3 OBJECTIVES REQUIRE EFFLUENT LIMITATIONS

In determining the need for an effluent limitation, the Regional Water Board shall use all representative information to characterize the pollutant discharge using a scientifically defensible statistical method that accounts for the averaging period of the water quality objective, accounts for and captures the long-term variability of the pollutant in the effluent, accounts for limitations associated with sparse data sets, accounts for uncertainty associated with censored data sets, and (unless otherwise demonstrated) assumes a lognormal distribution of the facility-specific effluent data.

The purpose of the following procedure (see also Figure VI-1) is to provide direction to the Regional Water Boards for determining if a pollutant discharge causes, has the reasonable potential to cause, or contributes to an excursion above Table 3 water quality objectives in accordance with 40 CFR 122.44 (d)(1)(iii). The Regional Water Board may use an alternative approach for assessing reasonable potential such as an appropriate stochastic dilution model that incorporates both ambient and effluent variability. The permit fact sheet or statement of basis will document the justification or basis for the conclusions of the reasonable potential assessment. This appendix does not apply to permits or any portion of a permit where the discharge is regulated through best management practices (BMP) unless such discharge is also subject to numeric effluent limitations.

Step 1: Identify C_o, the applicable water quality objective from Table 3 for the pollutant.

Step 2: Does information about the receiving water* body or the discharge support a reasonable potential assessment (RPA) without characterizing facility-specific effluent monitoring data? If yes, go to *Step 13* to conduct an RPA based on best professional judgment (BPJ). Otherwise, proceed to *Step 3*.

Step 3: Is facility-specific effluent monitoring data available? If yes, proceed to *Step 4.* Otherwise, go to *Step 13.*

Step 4: Adjust all effluent monitoring data C_e, including censored (ND or DNQ) values to the concentration X expected after complete mixing. For Table 3 pollutants use $X = (C_e + D_m C_s) / (D_m + 1)$; for acute toxicity* use $X = C_e / (0.1 D_m + 1)$; where D_m is the minimum probable initial dilution* expressed as parts seawater* per part wastewater and C_s is the background seawater* concentration from Table 5. For ND values, C_e is replaced with “<MDL*;” for DNQ values C_e is replaced with “<ML.*” Go to *Step 5*.

Step 5: Count the total number of samples n, the number of censored (ND or DNQ) values, c and the number of detected values, d, *such that* $n = c + d$.

* See Appendix I for definition of terms.

Is any *detected* pollutant concentration after complete mixing greater than C_o? If yes, the discharge causes an excursion of C_o; go to *Endpoint 1*. Otherwise, proceed to *Step 6*.

<u>*Step 6*</u>: Does the effluent monitoring data contain three or more detected observations ($d \geq 3$)? If yes, proceed to *Step 7* to conduct a parametric RPA. Otherwise, go to *Step11* to conduct a nonparametric RPA.

<u>*Step 7*</u>: Conduct a parametric RPA. Assume data are lognormally distributed, unless otherwise demonstrated. Does the data consist entirely of detected values ($c/n = 0$)? If yes,

- calculate summary statistics M_L and S_L, the mean and standard deviation of the natural logarithm transformed effluent data expected after complete mixing, $\ln(X)$,
- go to *Step 9*.

Otherwise, proceed to *Step 8*.

<u>*Step 8*</u>: Is the data censored by 80% or less ($c/n \leq 0.8$)? If yes,

- calculate summary statistics M_L and S_L using the censored data analysis method of Helsel and Cohn (1988),
- go to *Step 9*.

Otherwise, go to Step 11.

<u>*Step 9*</u>: Calculate the UCB i.e., the one-sided, upper 95 percent confidence bound for the 95th percentile of the effluent distribution after complete mixing. For lognormal distributions, use $UCBL_{(.95,.95)} = \exp(M_L + S_L\, g'_{(.95,.95,n)})$, where g' is a normal tolerance factor obtained from the table below (Table VI-1). Proceed to *Step 10*.

<u>*Step 10*</u>: Is the UCB greater than C_o? If yes, the discharge has a reasonable potential to cause an excursion of C_o; go to *Endpoint 1*. Otherwise, the discharge has no reasonable potential to cause an excursion of C_o; go to *Endpoint 2*.

<u>*Step 11*</u>: Conduct a non-parametric RPA. Compare each data value X to C_o. Reduce the sample size n by 1 for each tie (i.e., inconclusive censored value result) present. An adjusted ND value having C_o < MDL* is a tie. An adjusted DNQ value having C_o < ML* is also a tie.

<u>*Step 12*</u>: Is the adjusted $n > 15$? If yes, the discharge has no reasonable potential to cause an excursion of C_o; go to *Endpoint 2*. Otherwise, go to *Endpoint 3*.

<u>*Step 13*</u>: Conduct an RPA based on BPJ. Review all available information to determine if a water quality-based effluent limitation is required, notwithstanding the above analysis in *Steps 1* through *12*, to protect beneficial uses. Information that may be used includes: the facility type, the discharge type, solids loading analysis, lack of dilution,

* See Appendix I for definition of terms.

history of compliance problems, potential toxic impact of discharge, fish tissue residue data, water quality and beneficial uses of the receiving water,* CWA 303(d) listing for the pollutant, the presence of endangered or threatened species or critical habitat, and other information.

Is data or other information unavailable or insufficient to determine if a water quality-based effluent limitation is required? If yes, go to *Endpoint 3.* Otherwise, go to either *Endpoint 1* or *Endpoint 2* based on BPJ.

Endpoint 1: An effluent limitation must be developed for the pollutant. Effluent monitoring for the pollutant, consistent with the monitoring frequency in Appendix III, is required.

Endpoint 2: An effluent limitation is not required for the pollutant. Appendix III effluent monitoring is not required for the pollutant; the Regional Board, however, may require occasional monitoring for the pollutant or for whole effluent toxicity as appropriate.

Endpoint 3: The RPA is inconclusive. Monitoring for the pollutant or whole effluent toxicity testing, consistent with the monitoring frequency in Appendix III, is required. An existing effluent limitation for the pollutant shall remain in the permit, otherwise the permit shall include a reopener clause to allow for subsequent modification of the permit to include an effluent limitation if the monitoring establishes that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above a Table 3 water quality objective.

Appendix VI References:

Helsel D. R. and T. A. Cohn. 1988. Estimation of descriptive statistics for multiply censored water quality data. Water Resources Research, Vol 24(12):1977-2004.

Hahn J. H. and W. Q. Meeker. 1991. Statistical Intervals, A guide for practitioners. J. Wiley & Sons, NY.

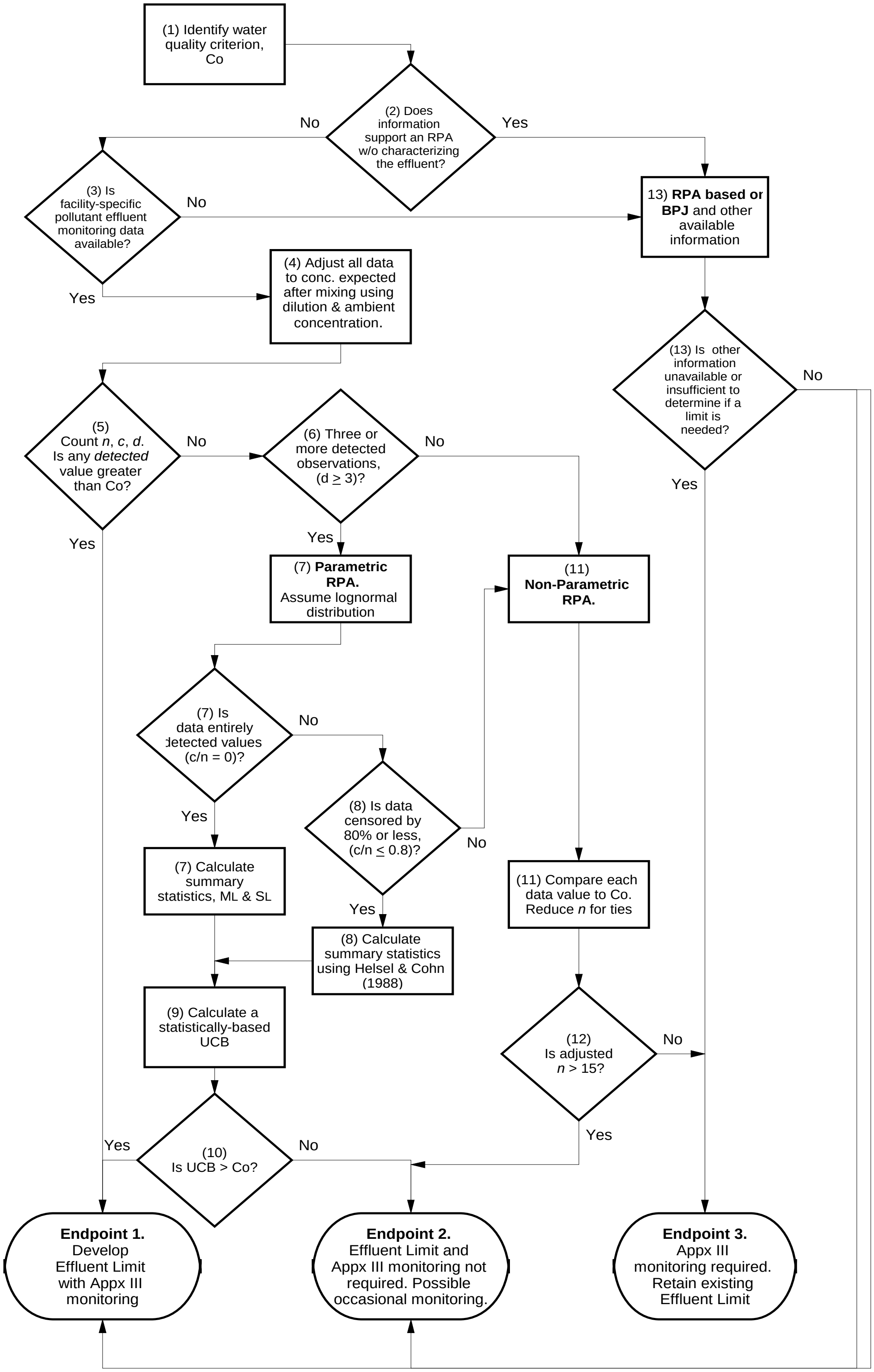
* See Appendix I for definition of terms.

Table VI-1: Tolerance Factors $g'_{(.95,.95,n)}$ for calculating normal distribution one-side upper 95 percent tolerance bounds for the 95th percentile (Hahn & Meeker 1991)

n	$g'_{(.95,.95,n)}$
2	26.260
3	7.656
4	5.144
5	4.203
6	3.708
7	3.399
8	3.187
9	3.031
10	2.911
11	2.815
12	2.736
13	2.671
14	2.614
15	2.566
16	2.524
17	2.486
18	2.453
19	2.423
20	2.396
21	2.371
22	2.349
23	2.328
24	2.309
25	2.292
26	2.275
27	2.260
28	2.246
29	2.232
30	2.220
35	2.167
40	2.125
50	2.065
60	2.022
120	1.899
240	1.819
480	1.766
∞	1.645

* See Appendix I for definition of terms.

Figure VI-1. Reasonable potential analysis flow chart



* See Appendix I for definition of terms.

APPENDIX VII
EXCEPTIONS TO THE CALIFORNIA OCEAN PLAN

Table VII-1
Exceptions to the Ocean Plan
(GRANTED BY THE STATE WATER RESOURCES CONTROL BOARD)

Year	Resolution	Applicable Provision	Discharger
1977	77-11	Discharge Prohibition, ASBS #23	US Navy San Clemente Island
1979	79-16	Discharge Prohibition for wet weather discharges from combined storm and wastewater collection system.	The City and County of San Francisco
1983	83-78	Discharge Prohibition, ASBS #7	Humboldt County Resort Improvement District No.1
1984	84-78	Discharge Prohibition, ASBS #34	Carmel Sanitary District
1988	88-80	Total Chlorine Residual Limitation	Haynes Power Plant Harbor Power Plant Scattergood Power Plant Alamitos Power Plant El Segundo Power Plant Long Beach Power Plant Mandalay Power Plant Ormond Beach Power Plant Redondo Power Plant
1990	90-105	Discharge Prohibition, ASBS #21	US Navy San Nicolas Island
2004	2004-0052	Discharge Prohibition, ASBS #31	UC Scripps Institution of Oceanography
2006	2006-0013	Discharge Prohibition, ASBS #25	USC Wrigley Marine Science Center
2007	2007-0058	Discharge Prohibition, ASBS #4	UC Davis Bodega Marine Laboratory
2011	2011-0049	Discharge Prohibition, ASBS #6	HSU Telonicher Marine lab
2011	2011-0050	Discharge Prohibition, ASBS #19	Monterey Bay Aquarium
2011	2011-0051	Discharge Prohibition, ASBS #19	Stanford Hopkins Marine Station
2012	2012-0012, as amended on June 19 2012; in 2012-0031	ASBS Discharge Prohibition, General Exception for Storm Water and Nonpoint Sources	27 applicants for the General Exception

* See Appendix I for definition of terms.

APPENDIX VIII
MAPS OF THE OCEAN, COAST, AND ISLANDS

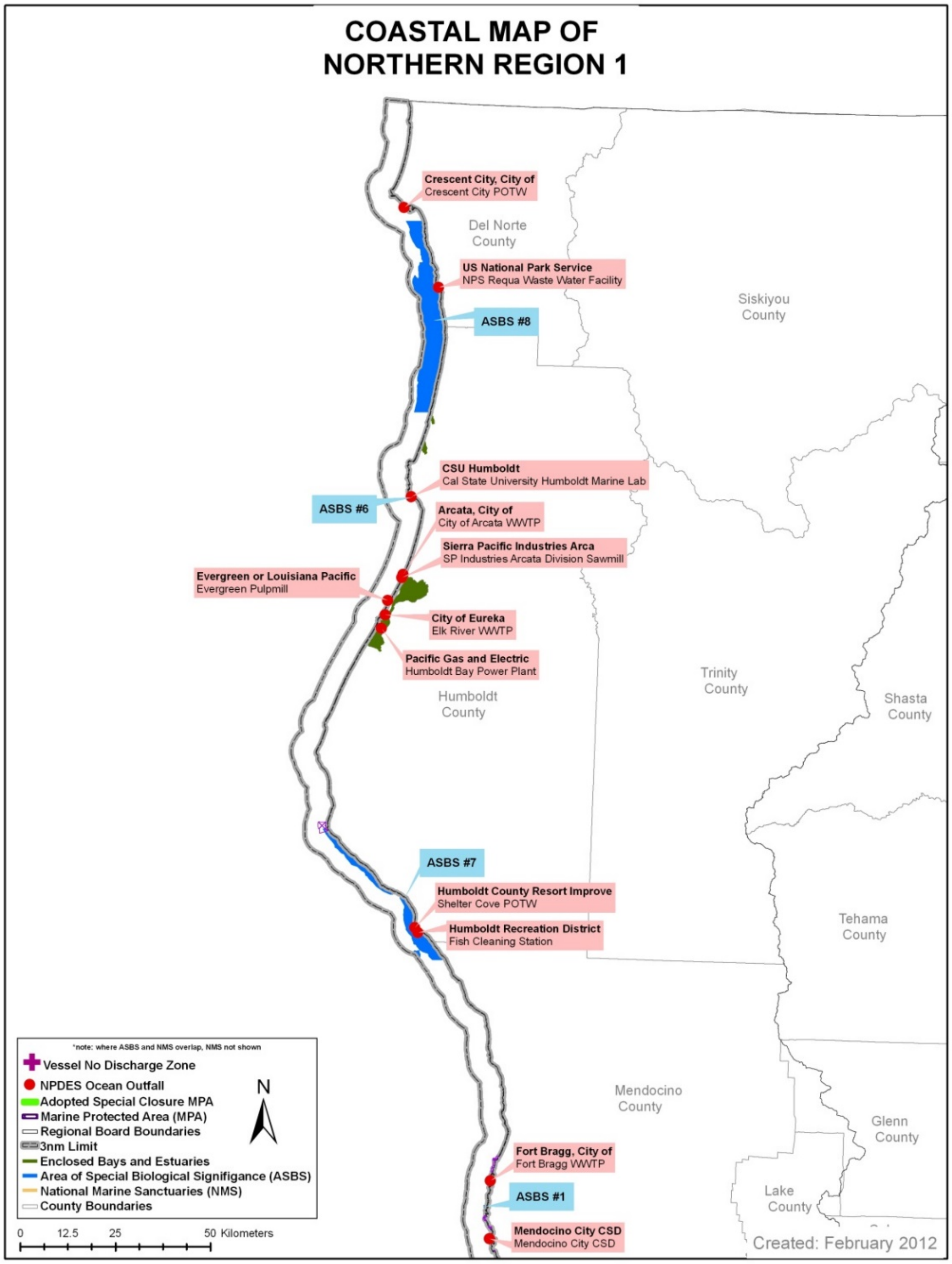


Figure VIII-1. ASBS Boundaries, MPA Boundaries, Wastewater Outfall Points, Marine Sanctuary Boundaries, and Enclosed Bays in northern Region 1.

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* See Appendix I for definition of terms.

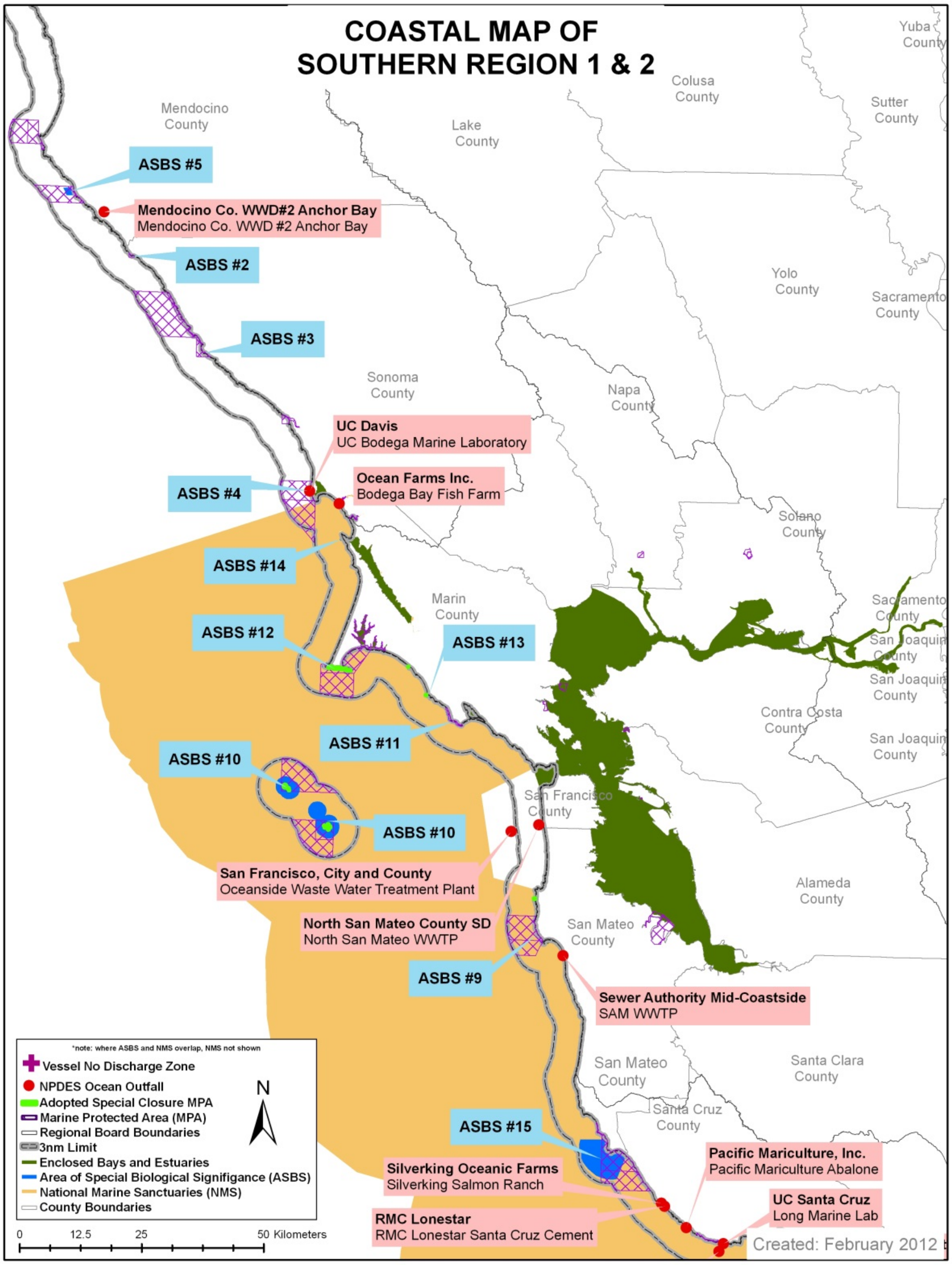

Figure VIII-2. ASBS Boundaries, MPA Boundaries, Wastewater Outfall Points, Marine Sanctuary Boundaries, and Enclosed Bays in southern Region 1 and Region 2.

* See Appendix I for definition of terms.

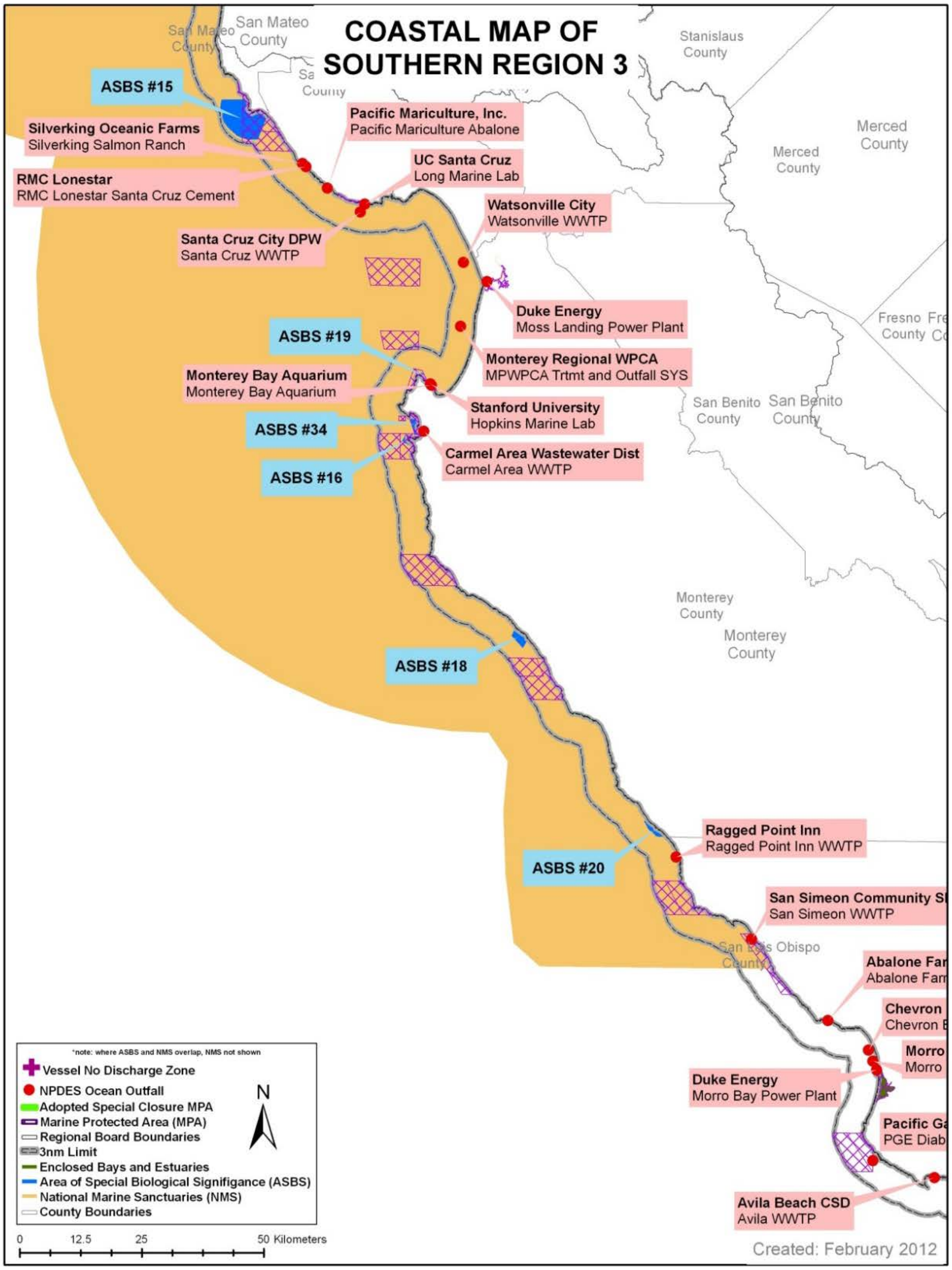

Figure VIII-3. ASBS Boundaries, MPA Boundaries, Wastewater Outfall Points, Marine Sanctuary Boundaries, and Enclosed Bays in northern Region 3.

* See Appendix I for definition of terms.

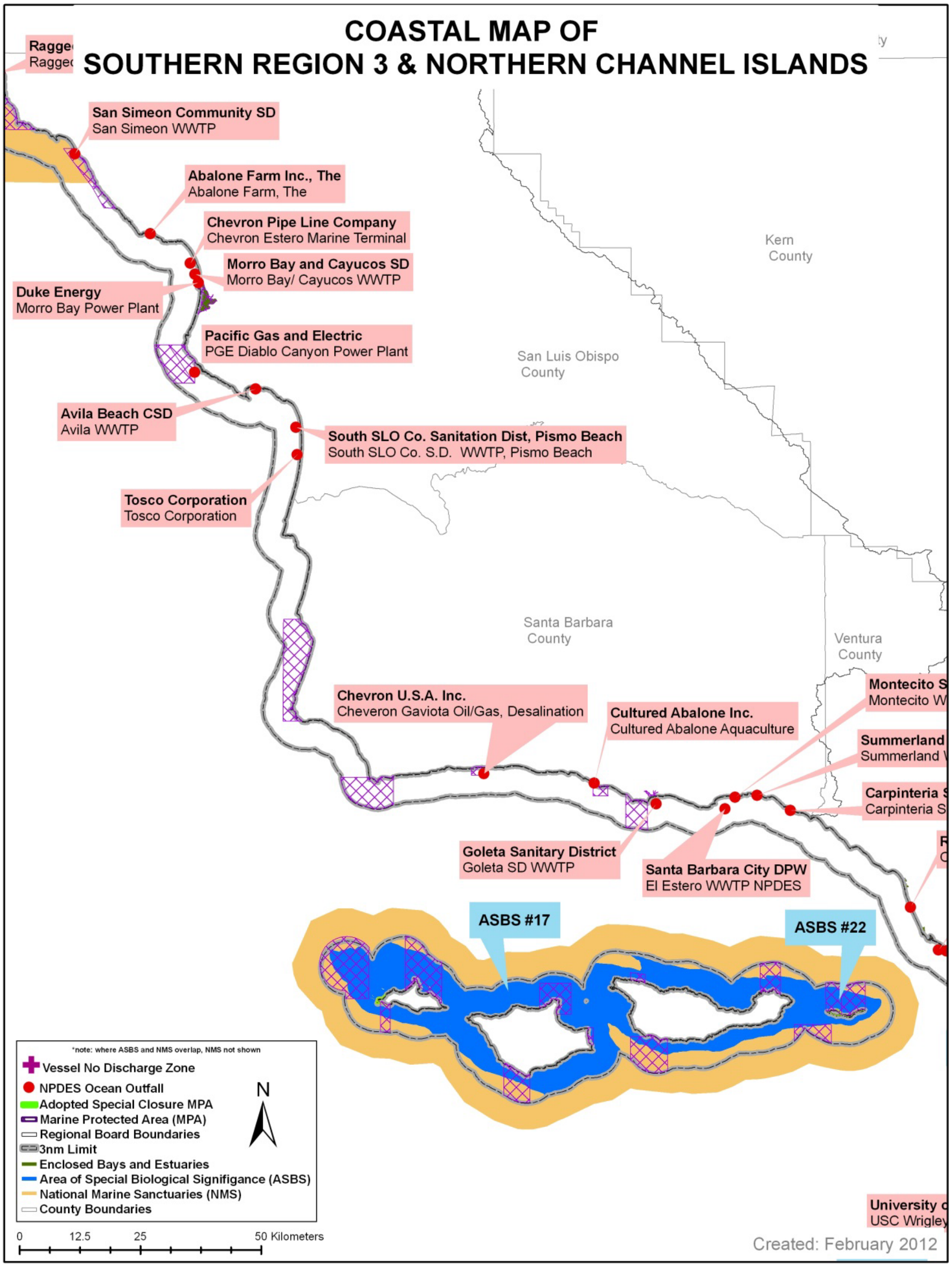

Figure VIII-4. ASBS Boundaries, MPA Boundaries, Wastewater Outfall Points, Marine Sanctuary Boundaries, and Enclosed Bays in southern Region 3 and northern Channel Islands.

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* See Appendix I for definition of terms.

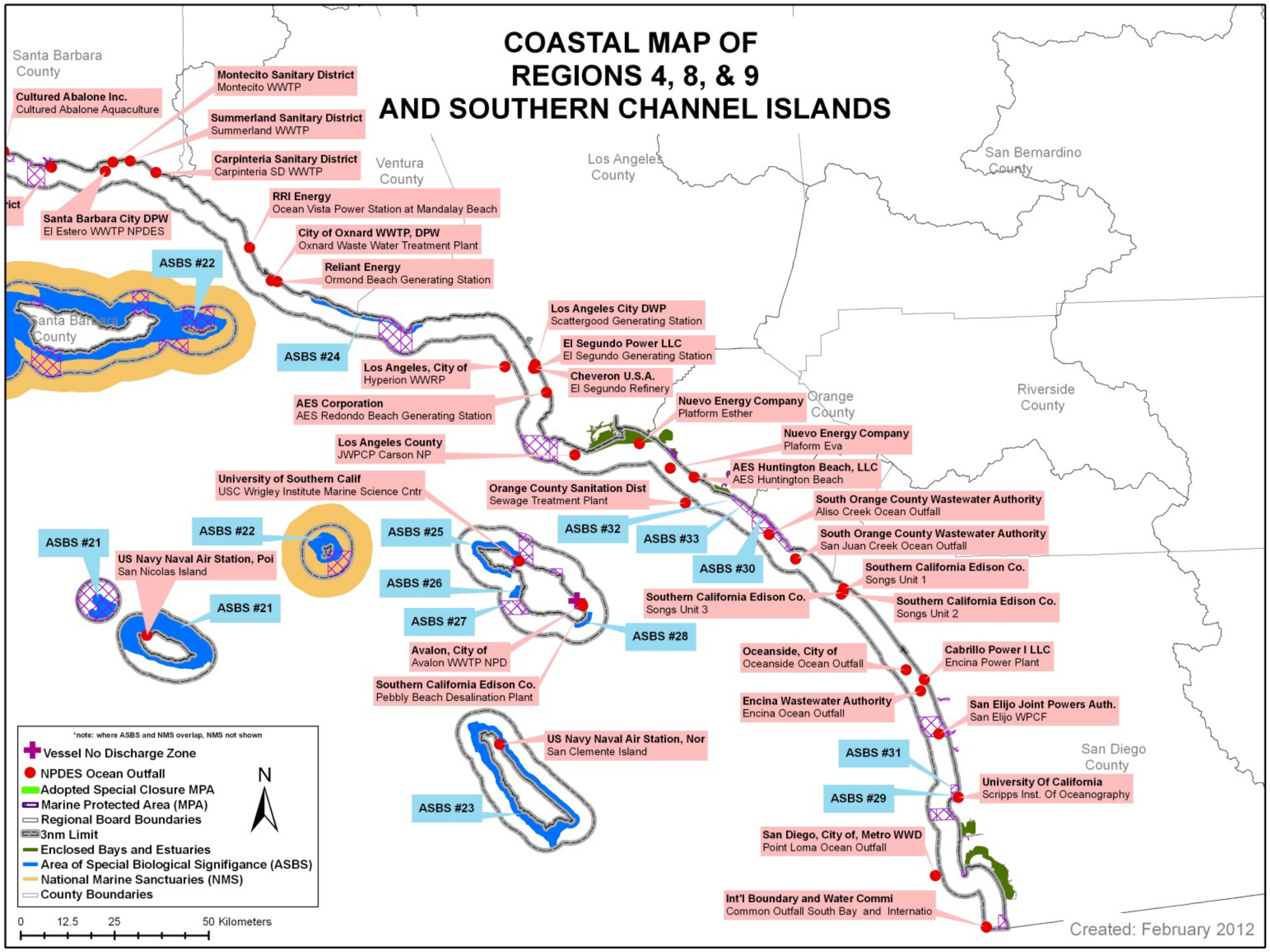

Figure VIII-5. ASBS Boundaries, MPA Boundaries, Wastewater Outfall Points, Marine Sanctuary Boundaries, and Enclosed Bays in southern Channel Islands and Regions 4, 8 and 9.

* See Appendix I for definition of terms.

Appendix U

Correspondence

City of San Diego
Public Utilities Department

March 2022

March 17, 2022

Mr. Dave Gibson
Executive Officer
Regional Water Quality Control Board, San Diego Region
2735 Northside Drive, Suite 100
San Diego, CA 92108-2700
Submitted via email to sandiego@waterboards.ca.gov

Dear Mr. Gibson:

Subject: Request for Determinations of Compliance, City of San Diego 301(h) Modified Permit Application

Regional Water Quality Control Board (Regional Board) Order No. R9-2017-0007 (National Pollutant Discharge Elimination System (NPDES) CA0107409) regulates the treatment and discharge of wastewater from the City of San Diego (City) E.W. Blom Point Loma Wastewater Treatment Plant to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO). The purpose of this letter is to request a determination from the Regional Water Board, as required by 40 Code of Federal Regulations (CFR) 125.61(b)(2), that the PLOO discharge complies with applicable provisions of State of California legal requirements and water quality standards.

Purpose of Requested Compliance Determinations. Order No. R9-2017-0007 expires on September 30, 2022, and the City of San Diego is required to submit a report of waste discharge in the application for renewal of the Order 180 days in advance of this expiration date. As part of this application, the City will be requesting that the U.S. Environmental Protection Agency (EPA) renew modified secondary treatment standards for the PLOO discharge pursuant to provisions of Section 301(h) and 301(j)(5) of the Clean Water Act. The City's 301(h) application is being developed in accordance with the format established in 40 CFR 125, Subpart G. As part of the 301(h) application, Section III.B.8 of Appendix B of 40 CFR 125, Subpart G, requires 301(h) applicants to:

1. Provide the determination required by 40 CFR 125.61(b)(2) for compliance with applicable provisions of State law, including water quality standards, or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.
2. Section III.G.2 of Appendix B of 40 CFR 125, Subpart G, also requires the City of San Diego to obtain a determination from the State that the PLOO does not cause additional treatment or control requirements on other regional point or non-point discharges.

For inclusion in our 301(h) renewal process, the City requests that the Regional Board provide updated determinations that the PLOO discharge (1) is in compliance with NPDES permit limits and provisions of the California Ocean Plan, and (2) does not affect treatment or control requirements on other regional point or non-point discharges.

In August 2017, EPA and the Regional Board jointly issued a renewed NPDES permit to the City that included a Clean Water Section 301(h) waiver from secondary treatment requirements for total suspended solids (TSS) and biochemical oxygen demand (BOD). EPA's 2017 decision was based on over 20 years of comprehensive receiving water and habitat monitoring data that demonstrates that the discharge of chemically enhanced primary treated wastewater 23,760 feet offshore at a depth of approximately 310 feet was not having a detrimental effect on the ocean environment.

Monitoring information submitted by the City to the Regional Board pursuant to Order No. R9-2017-0007 demonstrates that the PLOO discharge has achieved virtually 100 percent compliance with all effluent concentration standards, performance goals, and other provisions of the California Ocean Plan established within Order No. R9-2017-0007. The submitted monitoring information further demonstrates that receiving waters near the outfall comply with all applicable federal water quality criteria recommended by EPA for the protection of aquatic habitat and human health.

Since receiving its initial 301(h) NPDES permit in 1995, progressive facilities improvements have resulted in a systematic reduction in discharged pollutants. Since 1995, TSS mass emissions discharged from the Point Loma outfall have been reduced during the periods of modification. Additionally, the City is embarking on a comprehensive plan called the Pure Water San Diego Program that will divert wastewater away from the Point Loma Wastewater Treatment Plant to upstream reclamation facilities that will produce highly purified water for potable reuse. Ultimately, this project will supply up to 50 percent of the City's drinking water demand from recycled wastewater, while also significantly reducing the discharge to the ocean through the PLOO. The initial phase of this project will become operational during the upcoming permit renewal period.

The City looks forward to submitting the NPDES permit renewal application for the PLOO by the end of March 2022. In addition to the required application elements, it will further demonstrate the City's commitment to the Pure Water San Diego Program. Please contact Rachel Davenport at (619) 758-2370 or RDavenport@sandiego.gov if you need any additional information in order to make the required determinations that the PLOO discharge (1) complies with applicable State of California water quality standards, and (2) does not cause additional treatment or control requirements on other regional point or non-point discharges.

Thank you for your assistance,

Juan Guerriero

Interim Director, Public Utilities Department

JG/rd

cc: Lisa Celaya, Executive Assistant Director, Public Utilities Department
Thomas Rosales, Assistant Director, Public Utilities Department
Craig Boyd, Deputy Director, Public Utilities Department

Peter Vroom, Deputy Director, Public Utilities Department
Rachel Davenport, Program Manager, Public Utilities Department
Peter Kozelka, Environmental Scientist, United States EPA
Fisayo Osibodu, Water Resources Control Engineer, San Diego Regional Water Quality Control Board

California Coastal Commission

Request for Consistency Determination

A request to the California Coastal Commission for a determination of consistency with the Coastal Management Act will be submitted upon release of the Tentative Decision by the EPA and Adoption of the permit by the Regional Board.

National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Request for Comments on Endangered Species

Upon submittal of the application the City will coordinate with the US Environmental Protection Agency on requesting consultation by NOAA’s NMFS on endangered species under their jurisdiction in accordance with provisions of the Endangered Species Act.

Information has been developed, and is included in the permit application, that can be used in conjunction with a submittal to NOAA NMFS.

National Oceanic and Atmospheric Administration (NOAA)
U. Fish and Wildlife Service (USFWS)
Request for Comments on Endangered Species

Upon submittal of the application the City will coordinate with the US Environmental Protection Agency on requesting consultation by NOAA, USFWS, on endangered species under their jurisdiction in accordance with provisions of the Endangered Species Act.

Information has been developed, and is included in the permit application, that can be used in conjunction with a submittal to NOAA USFWS.

National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Request for Comments on Essential Fish Habitat

Upon submittal of the application the City will coordinate with the US Environmental Protection Agency on requesting consultation by NOAA, NMFS, on essential fish habitat in accordance with provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

Information has been developed, and is included in the permit application, that can be used in conjunction with a submittal to NOAA NMFS.